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ABSTRACT

This set of teaching materials is geared toward students and teachers in grades 5-12 and focuses on the use of a geographic information system (GIS) to explore the world. The package consists of a booklet of instructional activities and background information about geographic information systems, a companion poster, and a software demonstration that provides a tutorial on GIS and spatial analysis. Activity goals include examining the concept of GIS and the basic components of this increasingly computerized geographic tool, and exploring an application using this technology that focuses on population distribution in the United States and some of the factors associated with these geographic patterns. (DDR)

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Explore Your World

with a Geographic Information System

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Explore Your World with a Geographic Information System

This teaching package designed for grades 5–12 contains

- This booklet of background information and classroom activities
- *Explore Your World with a Geographic Information System*—A companion wall-sized poster
- *ArcView Explorer*—A diskette tutorial introducing GIS and ESRI's ArcView software (forthcoming)

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Explore Your World

with a Geographic Information System

A Teaching Supplement for Grades 5–12
Introducing Basic GIS Concepts and Components

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Explore Your World with a Geographic Information System

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What is *Explore Your World with a Geographic Information System*?

Explore Your World with a Geographic Information System is a set of teaching materials geared toward students and teachers in grades 5–12. The package consists of this booklet of instructional activities and background information about geographic information systems (or GIS for short), a companion wall-sized poster, and a forthcoming diskette providing a demonstration tutorial on GIS, spatial analysis, and ArcView® GIS software.

The supplement aims to broaden students' geographic awareness and knowledge of the world around them by engaging in a graphic and instructional journey that

- Examines the concept of GIS and the basic components of this increasingly important computerized geographic tool

- Explores an application using this technology focused on U.S. population distribution and some of the factors associated with these geographic patterns

The companion poster provides graphics and short narratives about the tool and its use. The left side of the poster identifies key components of a GIS. The right side gives real-world examples of some of the working parts of a GIS. That is, it furnishes examples of the contents of a GIS (the notion of data layers and geography), illustrations of maps created using a GIS, and a sample of the kinds of questions explored using a GIS.

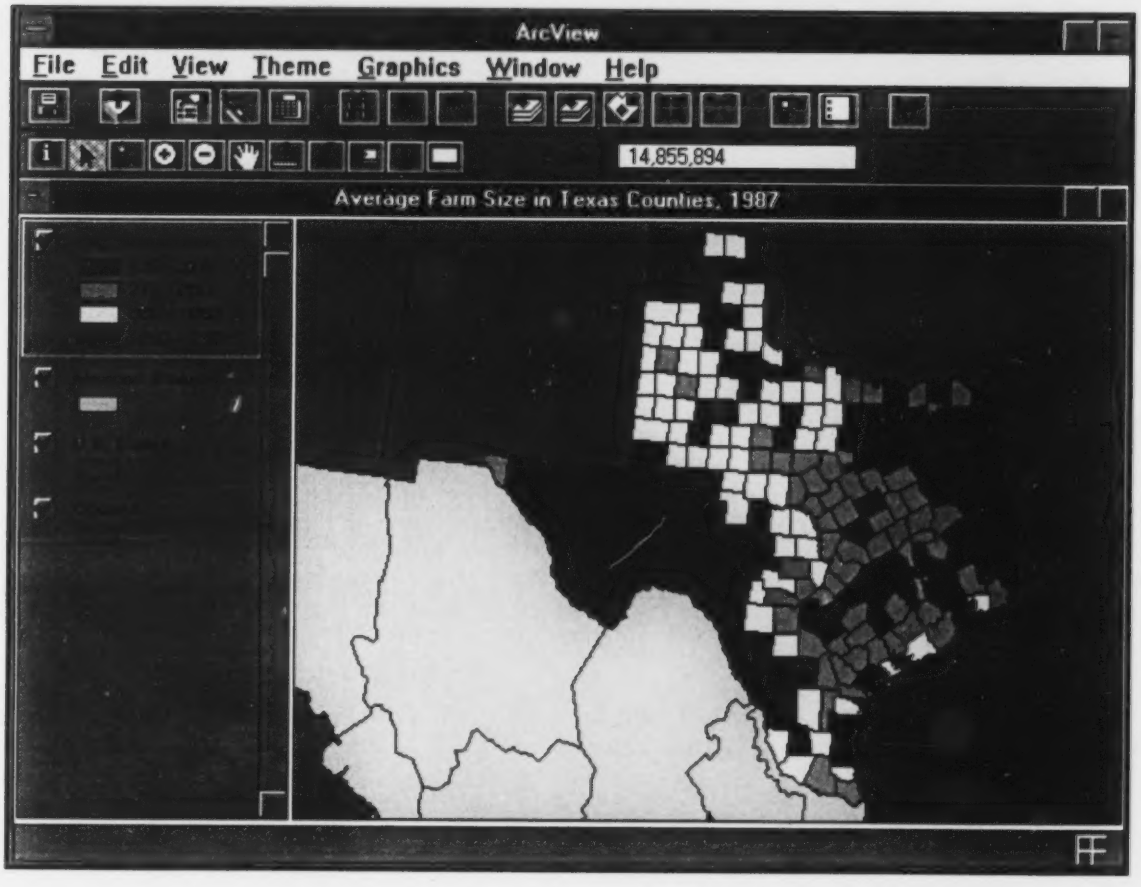
The instructional activities in the booklet add to the content of the poster by encouraging further exploration and learning about this geographic tool and its use in contemporary life. In doing so, the classroom lessons explore various themes in geography education and relate well to other discipline areas such as earth science and environmental education.

What is a GIS?

The use of computerized information is a growing part of everyday life. More and more people around the country and around the globe are plugging into geographic, social, economic, political, and environmental information to answer practical questions in their lives. The answers they find have relevance in their education, affect their business decisions, expand their understanding of the place they call home, and influence personal choices.

To explore this growing part of everyday life, people are using a range of electronic tools designed for acquiring, presenting, and interacting with information. One of these is called a geographic information system, better known as GIS. Basically, *a GIS is a system designed for storing, updating, analyzing, displaying, and manipulating spatial data—information about places on the planet. This system uses the power of the computer to answer geographic questions by arranging and displaying all kinds of data about places in a variety of ways such as via maps, charts, and tables.* That may be a mouthful to swallow in trying to understand what GIS is. Here's a simpler starting point. Begin by visualizing GIS as being largely about maps.

Maps are powerful tools. They help us plan trips ("Which roads will we drive to get to the Grand Canyon?"), find things ("Where in Texas are farms the smallest?"), and make decisions ("Based on the area's population growth, should we build another school?"). Possibly, most importantly, they help us imagine worlds. They help us envision people, places, things, trends, events, and other phenomena in ways that go beyond our individual locations and the immediate range of our five senses. Maps literally can guide, inform, and persuade us.



Maps come in a variety of forms. Some of the maps we use every day are in our heads—mental maps. For instance, that set of directions you mentally use every time you go to the grocery store. But generally, when you think of a map, the image that comes to mind is a diagram of part of the planet on a sizable sheet of paper that, at times, never quite folds back the way it was originally. There is, however, another image of maps quickly coming into the picture—electronic maps or geographic images that are viewable with a computer. At one end of this spectrum are simple electronic atlases. Much like their printed cousins, you can look at them but you cannot alter them. At the other end are geographic images created by the user, born of spatial data and software that engages the user in a wide range of computer-driven interactions and choices.

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GIS is at the upper end of the spectrum as a new breed of geographic decision making tool containing mapping, database, query, and analysis capabilities. The best way to understand GIS is that it is a mix of ***information about the real world*** (such as population, highways, rivers, and elevation). These layers contain data ***represented by points*** (like the location of fire hydrants in your town or state capitals across the country), ***lines*** (such as Interstate 70 or the Mississippi River), and ***areas*** (many-sided chunks of land such as New Mexico, the Superior National Forest, or Aroostook County, Maine). These are layers of spatial information ***that span a range of geographies*** (for instance, from areas as large and remote as Antarctica, down to a single city block in Alexandria, Virginia). Most importantly, all of these geographic and data pieces are tied together ***and can be explored with a computer*** and interactive software directed by geographically inquiring minds.

What do people use GIS for?

GIS is at work around the world and across your neighborhood. Here's a sample list of ways in which GIS touches everyday life:

- Planning school bus routes based on student residences
- Studying water consumption patterns in arid areas
- Designing noise abatement buffer zones around an airport
- Mapping current sewer service areas and projected need
- Profiling present bank customers by branch office
- Identifying telephone market territories across the country
- Researching changing wildlife habitat in a national park
- Modeling hurricane evacuation scenarios in a coastal city
- Laying out neighborhood newspaper delivery routes
- Analyzing patterns of toxic wastes in area soils
- Documenting archaeological sites and findings
- Viewing global vegetation cover from satellite images

This combination of data, geography, and computer hardware and software allows people interested in asking geographic questions the opportunity to rapidly develop hypotheses and explore a range of answers. For instance, why does the pattern of population distribution in the United States look the way it does—generally dense in the east and along the west coast, and sparsely settled west of the nation's midsection? The maps on the poster associated with this supplement graphically present this question and give an idea of some of the answers. The printed map images on the poster also point to one other important feature of a GIS: a GIS is dynamic. While the displayed maps were produced using a GIS, the minute they went on paper, they became forever the images shown. They cannot be changed on the poster. However, interacting with a GIS means investigating the world on the fly, changing the information used, the geography analyzed, and the questions posed. It means working directly with geography more like the way you live your life—moment by moment.

Where does GIS fit in the geography classroom?

GIS can be a vital part of elementary and secondary classroom instruction. In part, the growing presence of higher-powered computers in schools and the birth of national geography education standards are helping make this so. While a review of the elements and standards for geography education point to the importance of GIS as part of *'Seeing the world in spatial terms,'* GIS offers broader opportunities. (See the listing of the *'Six essential elements and eighteen standards in geography education.'*) GIS is about more than just technical tool know-how: it is about applying the tool and the know-how to real-world questions.

GIS is being used by growing numbers of geographers, urban planners, wildlife biologists, telephone company forecasters, highway engineers, farmers, bankers, realtors, natural resource managers, and others. For them, GIS is about applying problem solving to locational questions that deal with physical and human systems, their interplay, and the effects of

Six essential elements and eighteen standards in geography education

I. Seeing the world in spatial terms
   1. Maps, globes, and other geographic representations, tools, and technologies
   2. Mental maps and spatial context
   3. Spatial organization of earth

II. Elements: places and regions
   4. Physical and human characteristics of places
   5. Regions interpret earth's complexity
   6. Culture and experience influence perception of places and regions

III. Fundamental physical systems
   7. Physical processes shape patterns on earth's surface
   8. Characteristics and spatial distribution of earth's ecosystems

IV. Fundamental human systems
   9. Characteristics, distribution, and migration of human population
   10. Character and complexity of earth's cultural mosaics
   11. Patterns and networks of economic interdependence
   12. Processes, patterns, and functions of human settlement
   13. Forces of conflict and cooperation that shape divisions of earth's surface

V. Environment and society
   14. Human actions modify the physical environment
   15. Physical systems affect human systems
   16. Meaning, distribution, and importance of resources

VI. Applying geography
   17. How to apply geography to interpret the past
   18. How to apply geography to interpret the present and plan for the future

geographic choices on the past, present, and future. From this vantage point, a GIS in classroom teaching also acts as a springboard to addressing all of the national geography education standards such as understanding physical and human characteristics of place, earth's changing complexity, physical processes that shape patterns on the earth's surface, processes and patterns of human settlement, consequences of interactions between human and physical systems, and the power of geography in planning for the future. The inclusion of GIS in elementary and secondary education is, then, about fostering the growth of a geographically informed, globally responsible, and technically literate population now and in the future.

Classroom activities

The following six classroom activities are for use in conjunction with the information displayed on the poster. The lessons are aimed at helping you and your students explore aspects of geographic information systems.

The first three activities relate to the question "What is a GIS?" and the latter trio is intended to take students further into understanding some of the workings of a GIS by examining spatial data and distinct geographic patterns associated with "Where we live and where we don't." The lessons can be used independently or as a unit.

Activity set 1–What is a GIS?

This set of three activities is designed to assist in explaining the concept of a GIS. In *A GIS fable: The road less traveled*, students explore GIS components and decision making via an imaginary trip through a stoplight. *Making an Earth sandwich* presents students with a way to begin building an inventory of the kinds of geographic information that are in and that they would want in a GIS. Finally, *Let's do lunch: Mental mapping the neighborhood and siting a new service* asks students to engage in a creative real-world mapping exercise aimed at exposing them further to GIS components, decision making, and some interdependencies of the real world.

GIS: Not just for geographers

With the G-word in its name, it may seem that geographic information systems have been designed with only geographers in mind. That's far from true. The key to this name game is that GIS is about exploring information that is tied to specific places. There are lots of places on the planet and lots of different kinds of information. For instance, the facts and figures a student might examine could include social and economic traits of the people living in Minnesota counties. Other data sets might look at the extent of glaciers in the Himalayas in Nepal, the types and quantities of crops farmed in West Texas, changes in planetary greenhouse gases, or the migratory flyways of Canadian geese, or give a birds-eye survey of the Grand Canyon using satellite images.

In other words, since the topic being studied can vary, GIS is useful in many subject areas. These include a broad span of sciences (such as geology, earth science, archaeology, biology, botany, zoology, ecology, and even chemistry and physics), as well as mathematics and the full complement of the social studies (geography, history, sociology, economics, anthropology, and political science). Since an array of human and physical aspects of the world, a country, or a community can be examined simultaneously, GIS is an excellent tool for teaching in a single subject area and for engaging in interdisciplinary teaching in areas such as environmental education and global studies.

Activity set 1, lesson 1
A GIS fable: The road less traveled

Goals:

The goals of this activity are to help students

1) Gain an everyday sense of some of the components of a GIS.
2) Recognize GIS as a key geographic tool in seeing the world in spatial terms.

Objectives:

As a result of this activity, students will be able to

1) Identify the basic components of a GIS (***geography, data, a computer, and a thinking operator***).
2) Identify two virtues of using a GIS in decision making (***speed and flexibility***).
3) Construct a map using a written description.
4) Demonstrate how geographic information affects decision making.

Materials:

- Copy of the poster *Explore Your World with a Geographic Information System*
- Copies of the handout *A GIS fable: The road less traveled* (see page 8)
- Chalkboard and student drawing materials (paper, pencils, rulers)

Procedure:

1) Begin by briefly discussing the poster and the concept of GIS with the students. Use the poster text and appropriate portions of the narrative associated with this set of activities as your background information. From this booklet, use the discussion under the heading *What is a GIS?* (see pages 1–3).

   Emphasize the basic components of a GIS shown on the poster (information about the world, layers of data, etc.). When discussing the importance of the computer to this system, highlight that the ***speed of operations*** (e.g., data calculations, manipulation, analysis, display) and the ***flexibility of changing parameters*** (e.g., creating multiple what-if scenarios, changing the data, altering a map's composition) are two pluses in using a GIS in real-world decisions.

   Address the information content and source depicted in the poster's maps. (**Note:** For background on the maps, see *Poster data layers: A map menu* on page 22.) Have the students note where the poster's maps do and do not echo the basic components of a GIS.

GIS and paper maps: Where's the fit?

GIS component	Example from maps	Map–GIS fit?
Real-world information	Precipitation	Yes
Presented as shapes	Highways shown as lines	Yes
Range of geography	Counties	Yes
Explored with a computer		No—paper maps are static; GIS is dynamic
Human inquiry*	Every map on the poster	Yes, but static paper maps can lead to more questions than answers

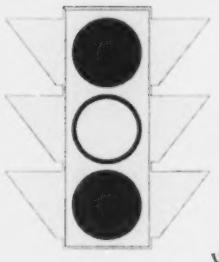
* No geographic inquiry happens without human involvement. The questions of where is it?, why there?, what if...?, how does it relate to...?, and so on are asked by people. Computers can provide answers, but it takes a thinking human operator to guide the questioning and make the choices.

2) Distribute copies of and read the story *A GIS fable: The road less traveled.* Once complete, discuss the story in relation to the prior discussion about the poster graphics. Reinforce the idea of GIS components and how the components work together.

3) To help visualize the story, have the students draw a map of the written geographic description. Direct them to include components such as direction, legend, scale, and physical locations. Once complete, draw on the chalkboard a version of the map that you have prepared earlier. Have the students compare their work and discuss the map content.

4) On the chalkboard map, bring to the students' attention the driver's three directional choices (turn right, go straight, or turn left). Ask them to call out a list of the information used by the driver to analyze each choice in modeling the decision on how to get home. Use the following categories: distance (e.g., the shortest route), speed of travel (e.g., slowest travel), hazards (e.g., street cave-in or bumper-to-bumper traffic), and other information (e.g., location of retail shops). Also, use this as an opportunity for the students to note some layers of data—streets, utilities, land use—in the driver's mental GIS and how these pieces fit together as interconnected systems.

5) Once complete, help the students make the connection between the organization and analysis of this set of spatial data and decision making using a GIS. For instance, in this imaginary scenario, the local transportation planning office might use a GIS to display the street cave-in, analyze traffic flow by time of day, and chart detours to improve morning and evening commuting. Ask the students to offer other suggestions of where a GIS might be useful. (Some examples are school bus route planning, location analysis for a new video store, predicting the path and damage of a major flood.) For more examples of GIS applications, use the list found in *What do people use GIS for?* on page 3.



A GIS fable: The road less traveled

You're in your car sitting at a red light. Once the light changes, you can turn left, right, or go straight. You know that any of these choices will eventually lead you home. Decisions, decisions. You've only got a minute or two before the light changes. What choice do you make? You notice that the cars have begun to creep down the southbound lanes of the cross street. You notice your watch. It's 4:15 p.m. Rush hour has started. Making a right turn would normally be the fastest route to your driveway but not at this hour. All you'll see through your windshield for the next five miles and fifty minutes will be brake lights. Looking up the street in front of you, you see no real traffic at the next few lights. Going straight seems a good choice but then you remember that a water main that burst yesterday caused a section of the road to cave in about a half mile up the road. Repairs were supposed to be done by now but, if not, it could be a bigger tie-up than the bumper car rush-o-rama headed south.

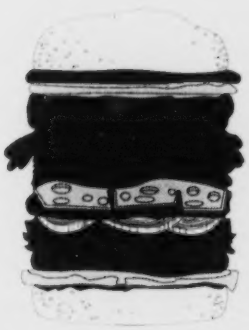
As the light turns green, you decide to take the left turn—to go north. Although there's some traffic and taking this route makes it the long way to your house, you know you can make stops at the supermarket and the video store and you'll arrive home in less time than the neighbor you just noticed making the turn into the heavy southbound traffic.

Know something? In that short span of time you were using a geographic information system or GIS. Yep, sounds strange but that's exactly what you were doing. Just like a real GIS, you were working with geography, data, and a computer. Not a computer somewhere under the hood of your car but the one in your head—your brain. At the speed of light, your brain was sizing up the situation, gathering information, displaying data, setting up what-if scenarios, analyzing the possibilities, and creating a geographic solution. That's what a GIS does.

Like a GIS, you weren't getting your geographic bearings from a paper map. The geography and data you were working with came in the form of a mental map—an image in your head made up of a combination of factual information about streets and the locatior of various retail shops, data updates such as traffic flow, and some guesses on the whereabouts of hazards like a street cave-in. You were computing distances and travel times based on your current position, the location of your home, and other variables such as bumper-to-bumper traffic. And you were changing the conditions of your trip on the fly, adding in visits to the grocery and videotape store (because you suddenly found yourself craving rocky road ice cream and a movie about fast cars).

However, the facts and the geography your brain can store, study, display, and juggle become less true-to-life as you try to add more of the world to your mental maps. A full-fledged GIS, on the other hand, can increase the size and complexity of those maps by offering you the ability to visualize and study information about places you've never visited as well as places you think you know. All of which still allows you the freedom to make the important choices like "Do I buy a pint or a quart of rocky road?"

Activity set 1, lesson 2
Making an Earth sandwich



Goals:

The goals of this activity are to help students

1) Understand some of the kinds of spatial data used in a GIS.
2) Recognize a GIS as providing a systematic way to understand aspects of the spatial organization of the earth's surface.

Objectives:

As a result of this activity, students will be able to

1) Identify some of the types of spatial data generally found in a GIS.
2) Recognize some of the associations between various GIS data layers.
3) Appreciate the inherent data input, updating, and expansion capabilities of a GIS.

Materials:

- Copy of the poster *Explore Your World with a Geographic Information System*
- Chalkboard and student writing materials

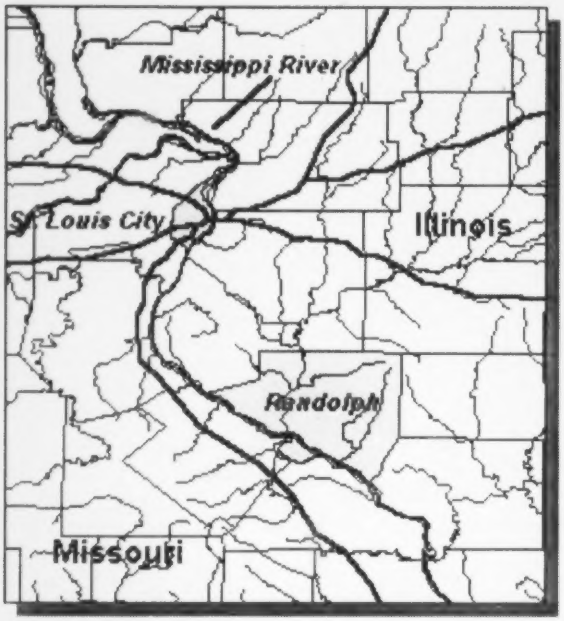
Procedure:

1) Take a moment to restate for the students what a GIS is.

> *Basically, a GIS is a system designed for storing, updating, analyzing, displaying, and manipulating spatial data-information about places on the planet. This system uses the power of the computer to answer geographic questions by arranging and displaying all kinds of data about places in a variety of different ways. One of the most effective ways to display geographic data is on a map.*

Expand on this discussion by engaging students in visualizing layers of information that stack on top of one another or are geographically related. Have them consider this using a place or an area of interest to them.

For instance, let's consider Randolph County, Illinois, southeast of St. Louis, Missouri. One view of the County is that it is an agricultural area. Three-quarters of its land is in farms. However, almost one-half of its over 34,000 residents are classified as living in an urban setting and nearly one in two employed persons work in manufacturing, retail trade, or health services. The County's landscape is gently rolling with sharp river bluffs along the Mississippi River and its floodplain. Besides thick deposits of limestone (which help



create distinctive sink holes on the surface), extensive coal fields are found in the County. It is crisscrossed by a variety of transportation lines: highways, railroads, and the Kaskaskia River navigation channel. While most of its more than 13,000 housing units were built after 1959, there are several important 18th Century French colonial sites. Known human settlement in its boundaries dates back to between 8000 and 10000 BC.

These and hundreds of other characteristics are geographically tied to an area known as Randolph County; all of them can be mapped and represented by points, lines, and areas. These sets of spatial information layer together to make up the physical geographic and human geographic mosaic of this County.

Stacking data inside a GIS is much like making an earth sandwich—a layer of this, a slice of that. But unlike a sandwich you eat (that is messy, at best, to take apart, change, and reassemble), you can alter this earth composite based on your imagination and the data at your disposal. You can change the mix of information, geography, and questions you wish to explore about as fast as you can think of them. Using the poster, bring the students' attention again to the components of a GIS, emphasizing the notion of the layering of geographic information.

2) Ask the students to create their own earth sandwich by having them offer suggestions of the sorts of data they would use in a GIS for a geographic area of their choosing (such as their hometown, county, or state).

As a starting point, have the students begin by breaking these layers into two major groups:

- *Physical layers*—information about the natural features of an area
- *Human layers*—facts about people, their structures, or their interactions with the land

To highlight this distinction, direct the students' attention to the eight maps on the poster. The maps on precipitation, elevation, and rivers fall into the category of physical layers. The remainder can be placed into the human category. Have them note that data about federal and agricultural lands fall into the human category since these classifications are a function of human definition and human interaction with the landscape.

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3) Solicit other layer ideas from the students. List these on the chalkboard under two major headings: physical and human. Some of the kinds of geographically tied information that are typically found in a GIS include

- *Hydrology*—such as rivers, streams, lakes, reservoirs, aquifers
- *Topography*—the physical features of a place or region such as elevation
- *Ecology*—such as types of vegetation cover and specific flora and fauna
- *Geology*—such as the geomorphology of an area and presence of geological risk factors
- *Land use*—essentially any use to which humans put the earth's surface such as agricultural, commercial, industrial, recreational, and residential
- *Utilities*—the above ground and below ground network of wires, cables, pipes, and tanks carrying electricity, water, sewage, and communications
- *Soil classes*—the quality or characteristics of the soil in various locations such as sand, loam, or clay or a soil's suitability for a specific land use
- *Streets*—the network of roads, highways, bridges, tunnels, and other thoroughfares
- *Land parcels*—such as the piece of property associated with a house, apartment building, or business
- *Other human characteristics*—such as demographic, socioeconomic, historical, political, or environmental characteristics of a place or region

A way to envision what can be included in a GIS database is if you can answer "yes" to the question, "Can it be mapped?"

The above list of categories does not, however, comprise an exhaustive inventory. Using copies of a local daily newspaper, have the students investigate local, state, national, and global issues/stories that could relate to GIS data layers. (Also be on the lookout for actual GIS articles and examples.) Some topical areas that could be included in GIS data layers might include crime, pollution, garbage disposal, traffic flow, ancient forests, war zones, fault lines, and cable TV service. One of the best ways to envision what can be included in a GIS database is if you can answer "yes" to the question, "Can it be mapped?"

Ask the students if they can picture any specific GIS applications that local newspaper stories suggest. As a beginning, use the list of GIS examples in *What do people use GIS*

GIS is about everyday life

The hometown news. Each and every day we see it, hear it, and read it... "and if the dry spell continues, water rationing will be necessary across the state especially in irrigated croplands"..."the growth of the beaver population in specific areas has effectively created new wetlands in the park"..."the Commissioner reported that the county is currently planning the locations of fifteen new recycling stations"..."it looks like the hurricane will make landfall south of the most populated areas, emergency centers are being set up to match the projected storm path"..."the auto maker is currently sizing up which plants in the country to close"..."rapid growth in parts of the city is forcing school district officials to examine sites for new schools"..."increased traffic loads have regional planners looking at a series of major road-widening projects"..."and the Mayor stated that with more single parents with young kids, she decided it was time to fund three new daycare centers in the affected neighborhoods"...

Besides being part of what makes the news, these stories have other common threads. They are about everyday life and they are all about events and choices tied to particular locations on the planet. They are part of the mosaic of where we live. While these specific news bites may not be about where you and I actually live, this is some of the news we each experience every day about our hometowns and other places around the globe—about events taking place, planning being performed, decisions being shaped, actions being taken.

Every day, thousands of these kinds of social, political, economic, and environmental choices are being made in communities across the country. Most are guided by a variety of statistical information and a keen sense of geography. More and more are being shaped by using GIS.

for? on page 3. Help the students make the linkage between human and natural events, patterns, and phenomena and the everyday nature of GIS. To further help the students in identifying specific data items tied to the everyday world around them, share the above narrative, *GIS is about everyday life.*

4) Using the list the students have created, ask them to examine at least some of their suggestions to decide whether the items in a particular layer are

- *Points*—like the location of a single oil well
- *Lines*—like an oil pipeline
- *Areas*—like an oil-producing area such as the Permian Basin in Texas

Again, use the depictions from the poster *What is GIS?* to highlight this discussion. Have the students notice how using different map scales can change a data item from a point (e.g., the location of Washington, D.C., on a page-size map of the United States) to an area (e.g., Washington as a 63-square-mile area represented as a multipaged map book), or from a line to an area (e.g., the Potomac River) under the same circumstances as noted above. The students might think of this along the lines of what happens when someone looks through the viewfinder of a camera while using the zoom lens.

Activity set 1, lesson 3
Let's do lunch:
Mental mapping the neighborhood and siting a new service

Goals:

The goals of this activity are to help students

1) Examine some aspects of using GIS in analysis and decision making.
2) Explore the spatial context of an area known to them and use their personal geographic framework in that exploration.

Objectives:

As a result of this activity, students will be able to

1) Sketch a map of the neighborhood around the school from memory.
2) Identify the relative location of geographic features in the neighborhood.
3) Analyze differences/similarities between depictions of each other's mental maps.
4) Recognize patterns of interdependency among various geographic features.
5) List some elements important to locating the site for a new service.
6) Relate various aspects of their mental maps to basic GIS components.
7) Understand, at least in elemental fashion, how GIS enhances geographic analysis.

Materials:

- Copy of the poster *Explore Your World with a Geographic Information System*
- Copy of local street map(s) depicting the area around the school
- Chalkboard and student drawing materials (paper, pencils, ruler)
- Local government planning documents for the neighborhood (optional)

Procedure:

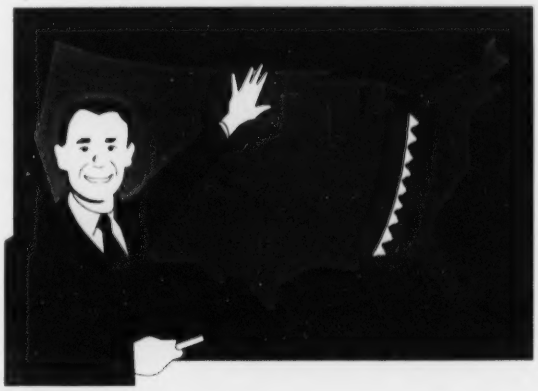
1) Have the students imagine the following scenario:

> *Each is a successful businessperson and, as such, each is financially well off. Being civic-minded souls, for the past few months, these shrewd entrepreneurs have been eyeing the neighborhood around the school as the site for a new business or community service. Each has something in mind but at this point none has begun to put that dream on paper...until today.*
>
> *A number of these like-minded businesspersons have gotten together for lunch to pool their financial resources and ideas in an attempt to help their neighborhood. As a*

5) Using the list the students have generated, ask them to begin grouping like items together. Have them notice that there can be data layers within data layers. For instance, education might be one of the areas the students have identified. Within this layer, there can be a whole series of other data sets dealing with educational characteristics of students, the location of schools, the network of bus routes, and so forth.

   As students make these groupings, have them notice how the various layers of data relate to one another (within and among categories). Direct them to also consider how this compilation of layers gives them a broader and more complete look at the interdependency of the world around them.

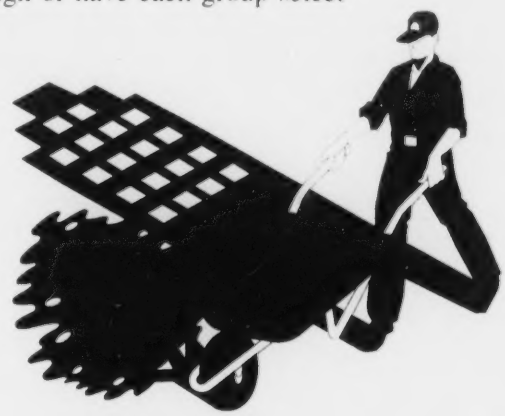
   In completing this process, ask the students to simply recognize the sheer volume of data they might want to include in a GIS and the fact that a fair amount of data changes over time (such as basic weather information reported on television or the population of their home community). Finally, reinforce the notion that one of the best ways to process, update, manipulate, analyze, and display this wide range of geographic information is by using GIS and the power of the computer.



group, they have decided that by the end of lunch they will know what business or service (daycare center, video store, teen center, park, swimming pool, etc.) they want to construct in the neighborhood.

They will have identified their first choice location for it. Lastly, they will have generated a list of aspects of the neighborhood that may be affected by their decisions—information they will report to the local government planning commission in order to win approval of their plan.

2) Break the class into small working groups. Assign or have each group select a spokesperson, a map maker, and a recorder. Each working group is a luncheon party, which means that each group will be developing its own solutions to the above scenario.



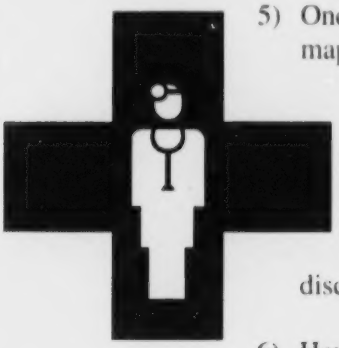
3) Have the students begin describing their neighborhood and what's in it. The way they will accomplish this is by drawing a map of the area from their collective memories. Direct the students to imagine in their mind's eyes a map of the neighborhood around the school. To help limit the scope of these mental images, give the students a set of streets or other geographic feature limits for the boundaries of the neighborhood.

   Have each group create its map of the area including as much detail as possible (e.g., streets, alleys, stores by type, locations of parks, social services, vacant lots, abandoned buildings, houses, and other key features). Each group's map maker will be responsible for graphically articulating the group's collective mental map. Suggest that each group create a draft and a final map.

4) Help the students recognize that the various geographic features, buildings, and other neighborhood characteristics they are identifying and drawing relate to some of the data layers discussed in the prior activity *Making an Earth sandwich*. Also, use the *What is GIS?* illustration from the poster to help clarify questions.

   To bring this home, have them use the short list of data layers noted in step 3 of *Making an Earth sandwich*, or use the list they created during the completion of that activity. As a result, some groups may want to create multiple maps that begin to relate to some of these individual layers or characteristics. For instance, besides making a basemap of streets and buildings, one group might want to map what it knows about unemployment in the neighborhood because the new business it seeks to create will be aimed at adding 100 new jobs in the area and the group wishes to draw its workers from a pool of local

residents. Help the students see how these data layers relate to their overall decision making process. In other words, have the students take note of how geographic data about the neighborhood are helping guide their decisions.



5) Once the final map renderings are complete, have each group use its mapped information as a guide in helping decide what business or service it wants to locate in the neighborhood. Have the students consider what service or shop they think is missing or is in short supply or that they believe would make a great addition, such as a new health center. Based on these discussions, have each group select a single service or business to add. Have the group recorders keep track of the discussions and these choices.

6) Have the students recognize that simply wanting to add the service or business to the neighborhood is not enough. Whatever is chosen must literally fit somewhere in the neighborhood.

- How much space will this new enterprise require?
- What will it be adjacent to?

Using their maps, have each group identify its prime location for the service or business. In choosing this location, have the groups examine the easy spots first: vacant land and abandoned or empty buildings. Have them also consider the location of any other similar service or business.

- Do they want to be close to or some distance from a potential competitor?
- Are there any existing services or businesses that would be a complement to this new venture?
- Do they want to be near a major road or away from one?

Help the students appreciate the notion that a GIS developed to include these kinds of data would be very useful in surveying what is currently on the ground and answering the very questions they are asking.

If the neighborhood is completely built up and there is no room for new structures, the students will have to demolish something or remodel an existing structure in order to locate their new enterprise.

- What structure(s) is the students willing to remove?
- What kind of remodeling or rehabilitation would an existing site require to house this new enterprise?

As the groups select their prime locations, suggest also that they take into consideration existing land uses (residential, commercial, agricultural, recreational, industrial, and so forth). For instance, if one group really wants to build a new landfill, putting it beside a housing development would probably not go over very well with the residents.

7) Having a copy of a neighborhood or area plan developed by or for your local government would be useful in helping your students navigate these geographic waters. Consider contacting your local government planning office or similar agency to obtain plans, maps, or similar documents. Also consider inviting a spokesperson from such an agency to make a presentation to your class or to be available as an expert consultant. In working with local plans and/or planning agencies, investigate the existence and use of a local GIS and any exemplary applications.

8) Once each group has tagged the prime location for its service or business, have each group review its choice by considering the impact of its placement, construction, and/or operation on the neighborhood in general and specifically on the area immediately surrounding the site. Have the groups imagine that they must go before the local government planning commission to gain approval for their plan. To prepare for this, have the groups go back to the data layer model and investigate the potential consequence or relationship of their new venture on various layers and sublayers.

   Ask the students to look at interdependencies between their choice of service or business and its geographic location and the physical and human characteristics of that area. How is it related to the area's hydrology, topography, ecology, geology, streets, utilities, land use, environmental quality, socioeconomic characteristics of the residents and so forth? Have the students list these items and note any potential issues they think would block their plan from gaining approval. In the face of a fatal problem, ask the students to rethink their plan or, at a minimum, be ready to respond as to how the benefits of their planned service or business outweigh any environmental, social, economic, or related costs.

   As with other steps in this activity, help the students see the link between the mapping, spatial analysis, and decision making activities they have been undertaking by hand and their completion with a GIS. For instance, do they think they could do at least some of these operations faster and easier and explore more layers of information and more complex questions by using a computer to manipulate and display geographic data?

9) Have the groups engage in role-playing by presenting their maps, announcing their service or business choices, and reporting their site-selection plans to the planning commission (the rest of the class). As issues about individual plans are uncovered, have the class offer suggestions of other kinds of information that they would want to examine to make a

better or more informed decision. Have the class also note and applaud the creative and decisive aspects of these real-world plans.

Additional ideas:

1) As an alternative, consider having each group report its findings and decisions at various points in the exercise, that is, as they complete their map, as they finalize their choice of service or business, as they finish the selection of the prime location for the new enterprise, and after they have generated their list of aspects of the neighborhood that may be affected by their decisions. In examining each others maps, have the groups note differences and similarities. (**Note:** For the discussion of map content, have handy a previously prepared transparency of the neighborhood or use a commercial map.)

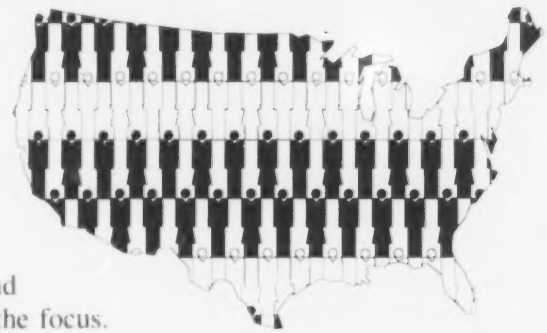
   In discussing service and business choices, have the students note where and how neighborhood geographic information came into play in those choices. Likewise, have them note where spatial data and human characteristics affected their other choices and decisions. How do the real-world data fit together? How do they interact?

2) To help the students 'ground truth' their mental maps and gain a more complete picture of the notion of the layering of geographic characteristics of places and interdependencies, consider a walking tour of the neighborhood upon completion of the exercise. Have the students make note of telltale signs that point to various data layers, such as gas meters, power lines, soil types, for sale and vacancy signs. Direct the students to either redesign their maps in the field or simply make a listing of the range and types of data they observe or would want to investigate in selecting a site for a business or service. As the breadth of the data grows, help them recognize that geographic data preparation, investigation, and display could also be handled by using a GIS.

Activity set 2–Where we live and where we don't

The preceding lessons gave students an idea of some of the foundations of GIS. This second set of three activities is designed to build upon this base by having students use GIS concepts and techniques to investigate population distribution within the contiguous United States. In *Shaping the human landscape,* students will begin exploring how physical and human characteristics have interacted to create the current picture of where Americans live. Initially, they will be referring to eight poster maps depicting 1990 census data, as well as a sample of other human and physical data. *Quantile mapping: More than GIS-t the facts* will involve students in creating their own map images of demographic phenomena (recent population estimates by state) and, as a result, in developing a list of geographic questions and an inventory of potential GIS data elements their displays and research suggest. Finally, *As you like it: A geographic guide to where you want to live* asks students to engage in personal decision making around possible future states of residence, to analyze the mental geographic databases they used in the process, to extend the activity with interviews of family members, and to consider how a GIS would be useful in the process.

Activity set 2, lesson 1
Shaping the human landscape



Goals:

The goals of this activity are to help students

1) Recognize some of the interactions and connections between the earth's physical and human systems using the United States as the focus.
2) Understand the concept of GIS data layers (made of points, lines, and areas), its connection to the earth's physical and human systems, and the appropriateness of the use of GIS in this kind of investigation.

Objectives:

As a result of this activity, students will be able to

1) Describe and suggest reasons for patterns of historic and contemporary human settlement/migration in the United States.
2) Compare and contrast aspects of population distribution by area of the country.
3) Describe some physical processes that shape landforms in this country.
4) List several ways in which physical systems have aided and impeded human settlement in this country.
5) List several ways in which technology and human intervention in the physical world have altered settlement patterns in this country.
6) Explain some of the relationships between population distribution and the natural world.

Materials:

- Copy of the poster *Explore Your World with a Geographic Information System*
- Copy(ies) of a North American or United States atlas, especially the National Geographic Society's *Historical Atlas of the United States* (optional)
- Copies of the *U.S. Population Estimates 1990–1993* handout from *Quantile mapping: More than GIS-t the facts*, the next classroom activity in this booklet (optional)
- Copy of the Census Bureau's *Statistical Abstract of the United States* or *State and Metropolitan Area Data Book* (optional)

Procedure:

1) Begin by informing the students that they will be investigating the current pattern of population distribution in the United States (or where people live and where they don't). Since this present geographic portrait has been built over time, also alert them that they will be exploring part of the historical foundation of why this pattern looks the way it

does today, how it has changed over time, and how the natural environment and technological change have influenced this demographic snapshot.

2) The starting points for their analysis are the population density and total population maps displayed on the *Explore Your World with a Geographic Information System* poster. Have them take note of the difference between the two maps. While both deal with 1990 population by county, the map on the left shows density or the average number of persons per square mile of land area in each county (or areas equivalent to counties [e.g., parishes in Louisiana]). The map on the right shows the total number of persons counted in the 1990 census in each county. Allow them the opportunity to notice the difference this makes in overall presentation and for individual counties. A helpful way to take note of this nuance is to have them observe the ranges shown in the map legends. Population density tops out at over 67,000 persons per square mile in a single county (New York County, New York) while the extreme value for total population is nearly 9 million people in a single county (Los Angeles County, California).

For additional background, use the discussion *Population density? Population count? What's the difference?* found on page 21. Also reference the description and source information about the poster maps, *Poster data layers: A map menu*, found on page 22.

3) Provide the students with the following information:

- The information shown on the poster's maps is from the 1990 Census of Population. In that census, the U.S. Census Bureau counted nearly 249 million persons living in the United States (50 states and the District of Columbia). (See the handout—*U.S. Population Estimates by State 1990–1993*—in Activity set 2, lesson 2 for population figures by state.) The Census Bureau estimate for late 1994 placed our population at nearly 262 million and its projections point to more than 276 million of us by the turn of the century. That's a lot of people.

- Depending upon where we live, we may feel that all of the more than one-quarter billion folks in the nation live next door to us, or we may feel like the only people on the planet.

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Population density? Population count? What's the difference?

Good question. Population density, as shown in the poster's map, is a depiction of the average number of persons per square mile of county land area, or the average spread of the population inside each county's boundaries. (**Note:** The land area used could have just as easily been whole states or some other geographic unit.) The population density map, like the map showing total population by county, provides a way of viewing population distribution. While the total population map gives a picture of the actual count of people that reside within a given unit of geography, the population density map gives a somewhat different picture.

By being standardized to a constant ratio (per square mile), population density gives a somewhat clearer picture of distribution by focusing on how close together or far apart people live on average. For instance, imagine an aerial photograph covering a square mile of residential land in San Francisco or another large city. The image you probably see includes many houses or apartment buildings with very little, if any, open land in between. Now, imagine another square mile aerial photo of part of a rural farm area such as inside Smith County, Kansas (home to the geographic center of the 48 contiguous United States). The picture that comes to mind is very different. It may contain a single home or only a few houses on the land or quite possibly no houses.

And what is meant by land? In this discussion, land area means dry land or land that is only temporarily or partially covered by water (e.g., an intermittent lake or a bog). This, then, means that the water area (any surface area covered by rivers, streams, ponds, lakes, reservoirs, and so forth) is not included in the calculation of population density. Despite taking a county's water area out of these computations, population density here is still considered an estimate since the land area used includes areas in which groups of people, generally, do not or cannot live. For instance, you generally do not find people (especially large clusters of people) living inside the Grand Canyon (or any other federal, state, or local protected area), on the top of the Continental Divide (or similarly rugged terrain), in the middle of a large farm belt, or other areas that restrict human habitation. And in true chicken and egg fashion, these parts of the country are generally those with low population density.

It is also useful to note that there is no such thing as a standard-sized county. Individual counties vary greatly in total square miles of land area. For instance, there are more than 18,000 square miles of terrain in Coconino County, Arizona (home of the Grand Canyon), but fewer than 60 square miles comprise Suffolk County, Massachusetts (home to Boston). A quick look at the poster maps shows that generally counties in states east of the 100th meridian are smaller in size than their cousins to the west.

On average, the 3,111 counties (and equivalent areas) in the contiguous United States contain just under 1,000 square miles of land area. However, this average figure is very different in states east and west of the 100th meridian. From essentially the Great Plains to the Atlantic, counties average under 700 square miles. Moving into the Rockies and heading for the Pacific, counties contain typically slightly more than 2,800 square miles of land. What this means in exploring a mapped data item such as population density is that the general pattern of decreasing population density visible as one heads west is a function of actual density decline as well as some sizably populated counties becoming invisible on the density map since their land areas are very large. This is, in part, why it is useful to look at population distribution expressed both as a count and as density.

Poster data layers: A map menu

The data sets used for the poster map images only touch the tip of the ever-expanding spatial data iceberg and provide the scantiest of introductions to the growing body of public and private data providers. The types and amount of spatial information about various aspects of the planet, its peoples, their institutions, and their interactions with the world around them continue to grow daily. As the students venture deeper into geographic inquiry, it is important for them to have some understanding of reliable sources of information and how to access needed facts and figures, and to have a better idea of where data come from. The annotations below give a brief synopsis of the data items used in the poster maps and their source(s).

1990 population density and 1990 total population by county. These ArcUSA™ data are from the 1990 Census of Population and Housing conducted by the U.S. Bureau of the Census. The source data are from the bureau's *Public Law 94-171 Redistricting Data Files.*

Average annual precipitation. The data used in creating these generalized patterns of average annual rainfall span the 1980s and are from the *Global Ecosystems Database* (version 1.0) produced by the National Geophysical Data Center of the National Oceanic and Atmospheric Administration (NOAA).

Elevation. The image of general elevation was generated using data that were gathered during the 1960s and are contained on the *Global Ecosystems Database* (version 1.0) produced by the NOAA.

Perennial rivers, streams, and lakes. Drawn from the ArcUSA database, the source of this geographic information is the U.S. Geological Survey's Digital Line Graph (DLG) data files. To help make the image meaningful at the size shown, some third- and fourth-order streams were not included.

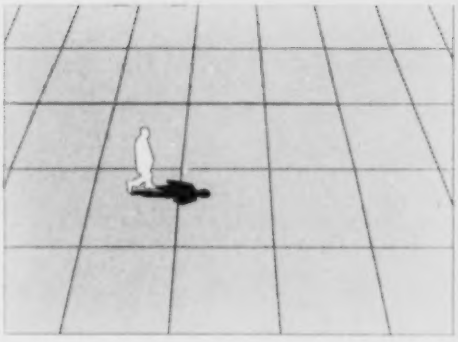
Percent of county in farms. A part of ArcUSA, this data set is from the Geographic Area Series of the 1987 Census of Agriculture conducted by the U.S. Bureau of the Census.

Percent of county in federal lands. Also found in ArcUSA, this spatial information is from the Oak Ridge National Laboratory's GeoEcology Database. The data reflect the extent of federal lands in 1977.

Limited access highways. Drawn from the ArcView database, the source of this geographic information is the U.S. Geological Survey's DLG data files and highway map updates. The data presented are limited to interstate highways, toll roads, and other limited access/divided highways.

Note: With the exception of precipitation and elevation, the data used in the poster map images were taken from ESRI's ArcUSA database. These data files, many of which are from a variety of federal agencies, consist of a broad range of cartographic, statistical, and geographic reference data provided on compact disc, immediately accessible using ESRI's ArcView software. The database presents the information for a variety of geographic levels within the conterminous United States at two scales: 1:2,000,000 and 1:25,000,000.

All things being equal, if we were to take the 1990 population and spread it evenly across the country, there would be just over 70 of us living on every square mile of land. That would give each of us a space of about 630' by 630'. But this is not the case. Portions of major cities far exceed 10,000 persons per square mile (or about 53' by 53') and other areas are without any people.



- The poster's population density and total population maps help give us a graphic snapshot of "where we live and where we don't" on a county-by-county basis. As we'll also see in a few minutes, these maps tell us more than just where we live. The maps encourage us to ask other geographic questions—most especially, *Why do the maps look the way they do?*

4) Have the students begin exploring the content of these two poster maps by simply observing some of the patterns evident. Have them orient themselves by focusing on where they live. Despite the relative size of the maps, have the students, as best as they can, find their home county or another area of interest to them. Have them note the level of population density and total population in this county. Direct them to examine the patterns found in adjacent counties. Are concentrations higher, lower, or about the same? Ask them if this initial exploration matches their preconceived images.

Have them extend this general investigation to include the full extent of the maps. What observations does this broader tour evoke? For instance, have them notice how density drops off dramatically moving across the middle of the country. Have them note patterns of heavy population concentration. Most importantly, have them recognize that the population is not evenly distributed across the land. To reinforce these, here are a few patterns for them to examine.

- A quick observation is that there are more of us in the eastern United States than in the west. In 1990, over 170 million people (just over two-thirds of the U.S. population) lived in states east of the 95th meridian (that is, east of the Dakotas, Nebraska, Kansas, Oklahoma, and Texas). Direct the students to place a pencil or ruler on either of the maps on a line approximating this boundary to accent this difference in population distribution.

- Also, ask the students to examine the population distribution patterns along the coasts. In 1990, nearly 132 million persons in the 48 contiguous states lived in counties and equivalent areas designated as coastal by the National Oceanic and Atmospheric Administration. This means that more than 53 percent of the 48 states' population resided along the Atlantic, Pacific, Great Lakes, and Gulf of Mexico coastal regions.

- Finally, direct them to pinpoint counties containing notable population centers: Denver, Minneapolis–St. Paul, St. Louis, Phoenix, Salt Lake City, Seattle, Dallas, Houston, Atlanta, the Boston–New York–Washington corridor, and others. Using a U.S. highway map or atlas will be helpful as individual cities become obscured in portions of the densely settled east and west.

Again, encourage the students to discuss how closely the depictions on these maps match their mental images of the information.

5) Once the students are familiar with the content of these maps, return to the question raised at the end of step 3: "Why do these population distribution maps look the way they do?" Or stated differently, "What are some of the factors that might help people choose to settle in one place and stop them from locating somewhere else?" Inform the students that they will, in part, be exploring these questions using the six map images shown on the poster that, in turn, relate to the notion of data layering in a GIS. (**Note:** See Activity set 1, lesson 2, *Making an Earth sandwich*, for a detailed discussion on GIS data components.) The students also will be expanding upon this set of six factors by proposing other influences that have a relationship to population distribution and concentration.

6) Provide the students with the following information:

- There are many factors that have influenced and continue to influence where and how many people live in this country. Some of them have to do with the ***physical makeup*** of the North American continent and with ***natural processes.*** Others are an influence of ***how humans have perceived the land and the choices made in its use.*** Still others are a part of the ***legacy of history:*** historical Native American and European involvement with and settlement of North America. Lastly, a number of key human factors at work in the past continue to shape the population patterns of today and tomorrow including such factors as ***technology***, ***economics***, ***politics***, ***societal values***, and ***personal choices.***

Ask the students to offer some suggestions of attributes, factors, and influences that fall under each of the key headings above (the highlighted text). It will be easier to turn the above statements into questions. For instance, what aspects of the physical makeup of the continent could have an influence on human settlement patterns? As you explore each of the headings, have the students recognize each as a data layer as seen inside a GIS. Have them note any geographic relationships among the various layers.

Below is a partial set of possibilities. (**Note**: This list will also take the students beyond the scope of the map images on the poster and suggest to them a broader view of the range of data they could examine on this topic and imply ways in which geographic information is linked together.)

7) Once the students have spent time investigating what some of the possible physical geographic, human geographic, and historical influences have been in helping shape where people do and do not live in the United States, direct them to suggest how these have affected population distribution and concentration. While you may want them to explore

Some factors affecting North American population distribution

Here is a sampler of some of the factors that have given and are giving shape to population distribution on this continent. Can you think of others? How do these help or hinder settlement?

■ Physical makeup (of the continent)	Its range of topography, vegetation cover, and soils.
■ Natural processes	The precipitation and temperature patterns for various areas.
■ Interaction with the land	Restricting or deterring human settlement in protected parks and wildernesses, in large agricultural expanses, or in environmentally tainted areas. Conversely, settlement on choice lands because it was easiest or seemed most sensible.
■ Legacy of history	The then-existing world powers and the direction of and location of early and sustained settlement.
■ Technology	Railroads, the automobile, superhighways, telecommunications, and air conditioning.
■ Economics	The changing presence of jobs in local and regional areas and changing national demands (e.g., farming/mining vs. manufacturing vs. service industries).
■ Politics	The acquisition of new territory, the opening of reserved lands to settlement, and changes in immigration policy.
■ Societal values	Religious freedom, the post-World War II baby boom, suburbanization, and retirement and recreation migration to sunbelt areas.
■ Personal choices	Moving to attend college, find work, be closer to other family members, and have an improved quality of life.

the full range of influences noted above, initially have them turn their attention to the poster maps. This will help them to begin seeing spatial relationships among data sets.

As the students examine the images shown, have them look for patterns linking the six maps together (e.g., precipitation, elevation, and rivers) but, most importantly, linking them to the patterns of population distribution in the upper maps. As they begin their exploration of each map, have them ask themselves "Where are the maps alike and different?" and "Why do they think the patterns are like that?" The following table (which continues on page 27), *Where we live, where we don't: Discussion ideas,* provides a brief description of each of the poster map images as well as questions to initiate dialogue among the students.

Where we live, where we don't: Discussion ideas

Poster map image	Description	Questions and ideas
Precipitation	This map gives a bird's-eye view of the general pattern of yearly precipitation shaded from driest to wettest.	In general, how does the presence or lack of rainfall affect where people live? For emphasis, approximate the 100th meridian on the population density and precipitation maps using a ruler or pen. Ask the students to discuss what they notice on either side of the line. Have them also notice and discuss the scattered population pockets in the dry west. (See step 9 for related discussion and questions.) **Note:** Further explore these and the questions connected with the other map images by using a U.S. historical or highway atlas.
Elevation	The elevation map shows a variety of heights of different landforms which can encourage or discourage human settlement.	How does the lay of the land influence population distribution? Have the students consider topographical features that make it easy/difficult for people to move and settle. As best as possible, have them notice low population density in the West Virginia–Virginia border area. Ask them to compare these patterns to the elevation map and the highways map. Consider a historical track by investigating roads and passes such as the Cumberland Gap and Santa Fe Trail. (See step 9 for other ideas.)
Rivers and streams	Precipitation and elevation have a direct impact on the distribution of rivers. This map provides a look at the location of most perennial rivers and streams.	What role have these water bodies played in shaping where people live? Approximate the 100th meridian on the population density and rivers maps. Ask the students to discuss what they notice on either side of the line. Also direct them to note population concentrations that are associated with various rivers and streams. (Further explore this historical relationship in step 9.)

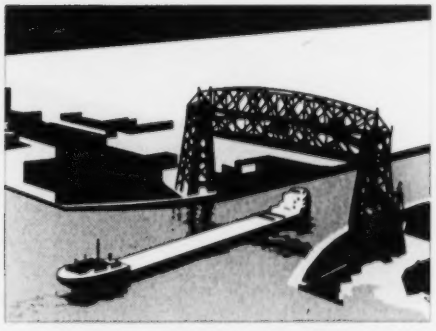
Where we live, where we don't: Discussion ideas (continued)		
Farm lands	The Great Plains, the Corn Belt, the Wheat Belt–much of this country's farming is in the middle of the continent. Not surprisingly, large portions of this area of the country are also relatively flat and well watered and have rich soils. Then again, whole segments of the agricultural center of the continent have markedly less precipitation than areas to the east.	What is noticeable about where farming is heaviest and where the population resides? Again identifying the 100th meridian, ask the students what they observe about farming concentration on either side of the line. In heavily farmed counties, have them consider the importance of irrigation and the source of the water used in counties west of the 100th meridian (e.g., the Ogallala aquifer which percolates below the high plains of Nebraska south into Texas). Also, have them examine relationships between the farm land, elevation, and precipitation maps.
Federal lands	Vast amounts of open or remote land are under federal control. They include national parks, forests, wilderness areas, military bases, American Indian reservations (and Alaska Native lands), and other types of land.	Where is the extent of federal land most prevalent and how do the various types affect settlement patterns? Which types of federal lands have people in residence (e.g., Native American lands and military bases)? Which types restrict residential use (e.g., a national park)? Have the students explore the concept of public domain and the history and uses of the lands held by the National Park Service, the Bureau of Land Management, the Fish and Wildlife Service, the Forest Service, the Bureau of Indian Affairs, the Department of Defense and the Department of Energy. Also have them compare the federal lands map with the precipitation and elevation maps. Do they see any relationships?
Limited access highways	Beginning in the 1950s many U.S. interstate and other superhighways were built providing access for millions of people to towns, cities, counties, and other regions of the country.	How does the presence of superhighways match where people live and how has the development of the nation's highway system affected and been affected by population change? How do the highway and population maps mirror each other? Ask the students to consider how the creation of highways and general access to privately owned vehicles have helped facilitate migration today and in the recent past, for instance during the Dust Bowl years. In this regard, have them note cities and areas that have grown in the age of the automobile (e.g., Los Angeles, Phoenix, Dallas, and Houston as well as retirement and recreation areas such as Washington County, Utah and Yavapai County, Arizona).

8) Finally, after exploring the poster map images, ask the students if they can suggest other relationships/patterns (from the list of influences discussed in step 6) that they feel are crucial to understanding the present-day picture of population distribution in the country. For instance, they may want to more completely discuss the role of economics and changing workforce and industrial demands on the population fortunes of specific parts of the country, or they may wish to get a better grasp of the importance of physical geography and changes in transportation in the history of population settlement (see step 9 for optional discussion and questions). In these final discussions, have them note the kinds of data they would like to investigate/map, the levels of geography they wish to explore, and how a computer and a GIS could help them further this study.

9) Optional discussion: Physical geography, transportation, and population settlement.

The foundation of population settlement in this country has been migration—the movement of people. While population change is determined by births, deaths, and migration, the settlement of vacant territory is first dictated by people moving to the area. This is seen, for instance, through the initial peopling of the continent via the Bering Strait land bridge, evident in pre-Columbian Native American settlements across North America (at places such as Cahokia in Illinois, Moundville in Alabama, Acoma Pueblo in New Mexico, and Mesa Verde in Colorado), and more recently through European and American settlement (such as St. Augustine, Florida, in 1565; Jamestown, Virginia, in 1607; Ste. Genevieve, Missouri, in 1735; and Oklahoma City, Oklahoma, in 1889).

Motivation has had much to do with the magnitude, speed, duration, and ease/difficulty of the movement of people into and away from various parts of the nation at various times. Some of these motivations have been the chance for free/cheap land, the lure of gold and other riches, the prospect of religious freedom, the call of a better place to put down roots as well as slavery, the forced relocation of native peoples, and war. But a settlement would never be launched or it would fade away if there were not a way to travel to it initially or sustain it after its start. The historical direction of population settlement in the United States has had much to do with accessibility, modes of travel, and transportation and supply corridors.



Below is a sketch to use in discussing some historical relationships between transportation and population settlement. As an aid in this, consider using a historical atlas such as the National Geographic Society's Historical Atlas of the United States. Throughout this discussion, have the students think about the types of data they would want to acquire in order to create a historical GIS of the United States.

Physical geography, transportation, and population settlement in the United States: Discussion ideas

Discussion points	Questions and ideas
While the presence of the Bering Strait land bridge is seen as the single most important factor in the initial peopling of North and South America, colonization by ship from across the Atlantic (especially by the English, the Spanish, and the French) primed a demographic pump that brought millions of people and goods initially to the continent's coasts, then to adjacent territories, and subsequently throughout its interior. The planting of many of these settlements and outposts from the late 15th century and continuing into the 20th century laid a foundation for many of the population patterns that are visible today in the United States.	Using the poster maps on population, have the students note varying levels of population concentration along the nation's coasts. Have them note the presence of population centers around naturally protected bays and harbors that were part of early coastal trade and travel. Ask them to examine current population density for locations such as Boston, Baltimore, Charleston, New Orleans, Detroit, Duluth (MN), Corpus Christi, San Diego, and San Francisco.
Historically, access to water both as part of human survival and as transportation has been a pull factor–an attraction for people. Rivers, river valleys, and lakes assisted in or became reasons for settlement and the relatively easy movement of people, goods, and services. The advent of steam power and the construction of canals made water an even more economical way of moving people and materials.	Have the students consider the relationship between these water-paved transportation corridors and the timing of the founding and the location of cities such as St. Louis, Memphis, Louisville, and Cincinnati along the Mississippi and Ohio Rivers. Using the poster's rivers map (or one from an atlas) and the population maps, have the students attempt to identify populated river corridors. While difficult using county-level data displays, some patterns are visible in the west, such as along the Snake River in Idaho.
Rivers afforded ways of moving people and trade not only by using their water but also by using their valleys as the location of trails, roads, and turnpikes. Thoroughfares such as the Genesee Road, the Wilderness Road (cutting through the Cumberland Gap), and the Great Wagon Road in part followed these water courses. They were joined by others as part of a growing network of national roads, some of which were best known as wagon and overland stage routes such as the Oregon and Santa Fe trails. As time and technology moved forward, some of these 18th and 19th century roads and trails evolved into, or are immediately adjacent to, parts of the present-day system of U.S. highways and interstates. Also across time, supply stations and forts along their courses turned into towns. Likewise, communities already in existence were linked to the growing road network.	While it is not possible to pinpoint any of these historical roads or their current highway counterparts using the geographic scale shown on the handout maps, it is possible to see the path of one such road through Nebraska because of the population footprint along parts of its route. This route is the Oregon Trail following the North Platte River and part of what is known as Interstate 80. To see this more clearly, have the students work with a U.S. highway or historical atlas, which will also help them see connections between specific population centers and present-day road systems. While working with a present-day highway atlas, have the students examine how the creation of superhighways has altered the population history of small communities along old parallel highways, such as Interstate 40 vs. Route 66 across parts of Arizona.

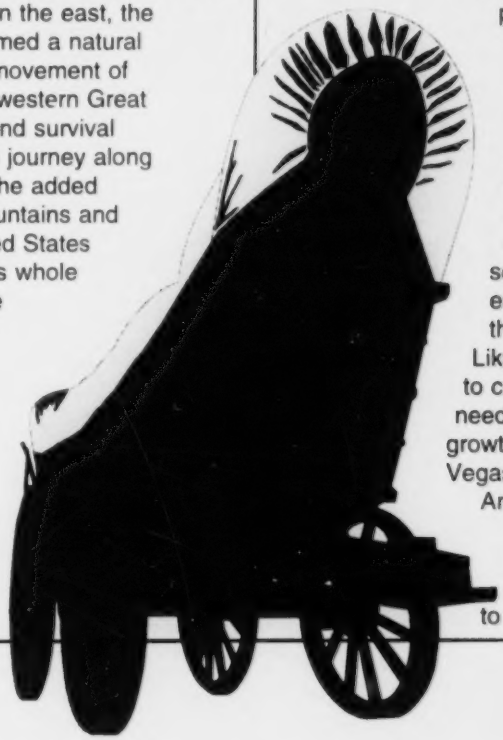
Physical geography, transportation, and population settlement in the United States: Discussion ideas

The 19th century in the United States was also the century of the railroad. Steam locomotive travel had its beginnings in the 1830s. By 1869 the nation was linked across its midsection by rail from coast to coast, and by 1883 four transcontinental railways were in operation. The rail lines followed paths of least resistance, some of which had been blazed by roads and trails as well as by rivers.

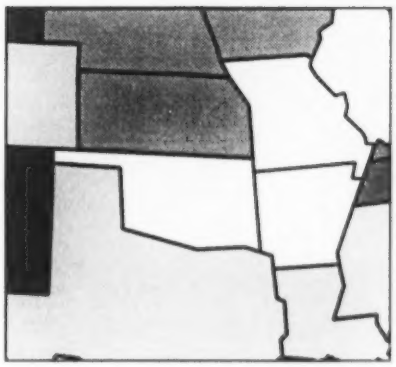
Have the students consider population centers that moved into the limelight as a result of railroads. Several to examine include Chicago, Kansas City, Cleveland, and Minneapolis–St. Paul.

While these various forms of transportation were a stimulus to the spread of population across the continent, parts of the physical terrain have stymied or funneled the movement of people and trade. Dry climates like deserts and rugged mountain regions have generally, until recently, been deterrents to large population movement and settlement or have fostered areas of limited population concentration. In the east, the Appalachian Mountains formed a natural blockade to the westward movement of population. While flat, the western Great Plains with limited rainfall and survival resources forced settlers to journey along specific routes. Likewise, the added hazards of the western mountains and the arid southwestern United States compelled people to bypass whole regions and also limited the spread of towns and small communities, unlike the pattern of rural development visible in the east.

Using the poster images and a historical atlas or U.S. highway map, have the students examine geographic areas that have restricted the movement of people. Ask them to identify specific locations or landform features that have afforded people access or passage in these areas of restricted movement. Have them examine historical settlement patterns in the desert southwest especially in and around El Paso, Albuquerque, and Santa Fe. Again, have them note the importance of water—the Rio Grande—as well as the presence of existing Indian pueblo settlements in the establishment of these then-Spanish outposts. Likewise, direct the students to consider water needs/supplies and the recent growth of places such as Las Vegas, Nevada, and Phoenix, Arizona. Ask them to discuss how these western communities and watersheds can continue to coexist.



Activity set 2, lesson 2
Quantile mapping:
More than GIS-t the facts



Goals:

The goals of this activity are to help students

1) Learn a technique of organizing geographic information into maps for further analysis.
2) Use their mapped output as a way of investigating geographic patterns and generating geographic questions, hypotheses, and generalizations.
3) Explore human geographic characteristics they might want as part of a GIS.

Objectives:

As a result of this activity, students will be able to

1) Create quantile maps of state level data.
2) Speculate about relationships between data they have mapped and data they have not seen.
3) Generate a list of specific data items they would want to use in further research and potentially seek out these data sets.

Materials:

- Copy of the poster *Explore Your World with a Geographic Information System*
- Copy of Census Bureau press release *Growth Rate of California's Population Drops Below the National Average*
- Copies of the *U.S. Population Estimates, 1990–1993* handout
- Copies of blank outline maps of the United States showing state boundaries
- Copies of the Census Bureau's *Statistical Abstract of the United States* or *State and Metropolitan Area Data Book* or an almanac with state level data (optional)
- Classroom set of colored pencils/markers

Procedure:

1) Inform the students that they will be investigating a number of geographic patterns about the United States. They will be primarily using a table of recent population estimates from the Census Bureau. They will be converting these numbers into hand-drawn map displays, spending time investigating patterns in individual maps, creating new displays from other data sets, and generating geographic questions, hypotheses, and generalizations about states across the country.

2) The mapping technique the students will be using is called ***quantile mapping.*** This method of graphically depicting statistical data divides (or codes) the geographic data into rank-ordered categories (or quantiles) where each category contains an equal number of geographic units–in this case, equal numbers of states. By using this approach with two or more data items (maps), students can engage immediately in geographic analysis and the development of hypotheses. By utilizing consistent coding patterns or colors across all maps, students can easily compare high- and low-value groups. Essentially, students are constructing graphic correlations of phenomena that are easier to see than if they were only working with the raw data. (**Note:** The statistics used here are for the period 1990–1993. More recent figures are available from the Census Bureau. The agency releases state population and migration estimates roughly on an annual basis. Contact the bureau at 301-457-2794 or on the World Wide Web at *http://www.census.gov*.)

   For instance, ranking and sorting the top ten states using demographic data derived from the handout table would show that states with the largest population increases between 1992 and 1993 were generally the states with the largest migration gains. Eight of the top ten states in each of the categories match in the listing below. (Note the states and values highlighted in bold.) Although not shown below, a comparison of the bottom ten does not produce as striking a relationship (only four out of ten). This is because the migration losers are generally states with large population bases while the states showing small population gains or losses are among the least populated states.

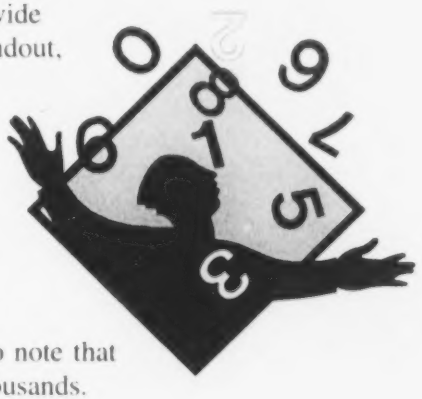
Top ten states in population increase and migration, 1992–1993

Rank	Population increase		Total migration*	
1	**Texas**	**349,000**	**Texas**	**160,000**
2	California	315,000	**Florida**	**148,000**
3	**Florida**	**196,000**	**Georgia**	**88,000**
4	**Georgia**	**144,000**	**Washington**	**72,000**
5	**Washington**	**113,000**	**Colorado**	**70,000**
6	**North Carolina**	**109,000**	**Arizona**	**69,000**
7	**Arizona**	**104,000**	**North Carolina**	**67,000**
8	**Colorado**	**101,000**	**Virginia**	**50,000**
9	**Virginia**	**96,000**	Tennessee	48,000
10	New York	88,000	Oregon	45,000

* Here total migration is the sum of the three components of migration presented in the handout table. In other words, migration increase = international migration (people moving to the U.S. from other countries) + migration of federal U.S. citizens (like armed forces and diplomatic personnel and their families moving back from overseas) + residual change (most of which is domestic internal migration–basically, the movement of people from state to state).

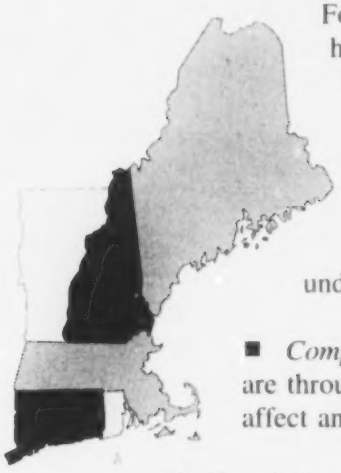
(**Note:** The above table highlights this technique's procedure of ranking and sorting and the notion of quantile correlations. It also highlights the impact of the second half of this procedure's name–***mapping.*** While it is known that eight states show similar patterns, the researcher cannot see them spatially except in a mental map. Physical maps displaying these two patterns would show these eight matching states to be in the south and west.)

3) Divide the class into small groups of 4-5 students. Provide each group with a copy of the population estimates handout, a handful of blank U.S. state outline maps, and an identical set of colored pencils/markers (based on the number of quantiles used). Using the handout data table, *U.S. Population Estimates 1990–1993*, choose a number of topics (data items) equal to the number of groups in the class. There are ten different topics that students could effectively map. These are



- *Total population*—Use the July 1993 estimate. Also note that most of the numbers in the table are rounded to thousands.
- *Population change*—In this table, it is number increase or decrease from 1992–1993.
- *Percent change*—Like population change, it covers the period 1992–1993.
- *Births*—This is the number of babies born from 1992–1993.
- *Deaths*—This is the number of persons (regardless of age) who died from 1992–1993.
- *Natural increase*—This is not shown but is a computed value of births minus deaths.
- *International migration*—This is the number of people moving to the United States from other countries between 1992 and 1993.
- *Migration of federal U.S. citizens*—This is the number of Americans working for the federal government (such as armed forces and diplomatic personnel and their families) who returned home between 1992 and 1993.
- *Residual change*—This is mostly the net amount of domestic migration in the country or basically the net movement of people from state to state (in-migration minus out-migration).
- *Total migration*—This, too, is not shown but is a computed value summing international migration, migration of U.S. federal citizens, and residual change.

4) As a way of setting the stage and helping the students better understand the data they are about to explore, read aloud the text of the Census Bureau press release, *Growth Rate of California's Population Drops Below the National Average*. Following this, allow the students to study the content and concepts contained in the handout table.



For instance, while they will be primarily investigating data for states, help them notice the data associated with the nation in total, areas defined as regions by the Census Bureau (Northeast, Midwest, South, and West), and subregional groupings of states known as divisions (for example, the New England states). Also use the data item descriptions noted in step 3 as aids in clarifying the concepts for the students. Lastly, use the following descriptions of population change and the components of change to help them understand how these various demographic items fit together.

- *Components of change*—The only ways in which a population changes are through changes in births, deaths, and migration. These human events affect an area's population growth, decline, or stability over time.

- *Population change*—Using the table's categories, change in an area's population for a given time period can be expressed as population change = births - deaths + international migration + federal U.S. citizen + residual change.

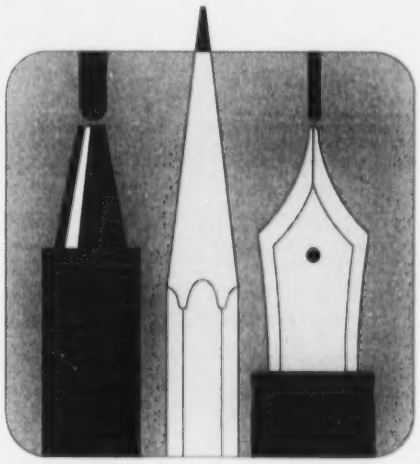
For example, population change in Colorado from 1992 to 1993 was estimated to be 101,000 persons. The sum of the components of change for that year shows this to be true. A one-year population gain of 101,000 persons = 54,000 births - 23,000 deaths + 6,000 international migrants + 3,000 returning U.S. federal citizens + 61,000 person net gain in migrants from other states. Population change can also be calculated by subtracting an area's current population figure from a previous one. For instance, Colorado's 1993 population estimate of 3,566,000 minus its 1992 estimate of 3,465,000 equals a gain of 101,000 persons.

(**Note:** Since the students are dealing with rounded numbers, they will find equations that will not be exact because of rounding [e.g., 1992–1993 population change in Kansas—2,531,000 minus 2,515,000 does ***not*** equal 15,000 as shown].)

5) Ask each group to rank the values for a different data item from highest value (1) to lowest (51). Determine the number of categories (quantiles) to display. The general rule of thumb is three to seven categories. Five categories work well when mapping data for the 50 states since they allow for ten states per quantile (except in the case of tied rankings). (**Note:** To facilitate this ranking/sorting procedure, have the students perform this operation on a separate sheet of paper.)

Once each group has ranked its data set, each group should divide the numeric information into the number of quantiles chosen. Using five categories (quintiles), simply count ten down from the top, then another ten, and so forth. Since there are 51 units of geography presented in the table (the District of Columbia is included), consider placing 11 values in the last quintile.

6) Direct the groups to transfer their quantiled data sets to the maps. To allow for consistent comparisons, have each group use the same colors in the same order to represent each separate quantile, such as red for quantile 1, orange for quantile 2, yellow for quantile 3, green for quantile 4, and blue for quantile 5. In creating each of these maps, have each group deal with the issues of titles, legends, and any special notes. Have each group create a second copy of its map.



7) Collect one copy of the maps from each group and display them. Using the visible set of maps and the group copies, ask the students to examine the information displayed and begin searching for geographic patterns and relationships, such as the top ten 1992–1993 population change and top ten 1992–1993 total migration increase states being nearly identical. Also consider allowing each group to offer a description of what it discovered in translating its tabular data into a map.

8) As this discussion progresses, ask the students to offer hypotheses of other data items that would help explain some of these patterns and relationships as well as other sets of information they think would be related. Make a list of these on the chalkboard.

To get things started, you might consider asking them the following question:

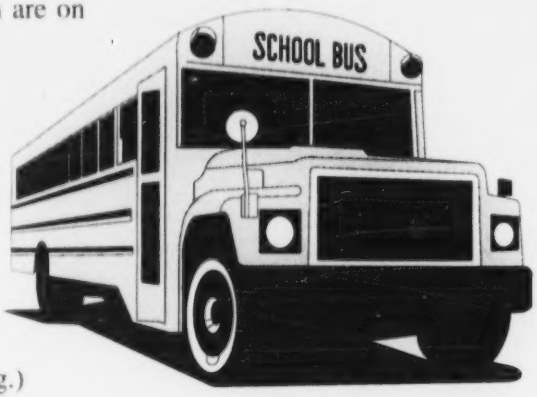
"If you know that a state is growing fast, what else might you expect to be happening?" Or in other words "What else might you assume?"

Some possible hypotheses could be

"I believe that if a state's population is growing rapidly:

- Housing prices are increasing.
- Apartment vacancies are down.

- Housing and commercial construction are on the rise.
- Unemployment is down.
- Service professions and retail trade jobs are increasing.
- Population density is increasing.
- Quality of life is changing (such as traffic, pollution, and crime increasing.)
- New schools, streets, land fills, and other services are needed."



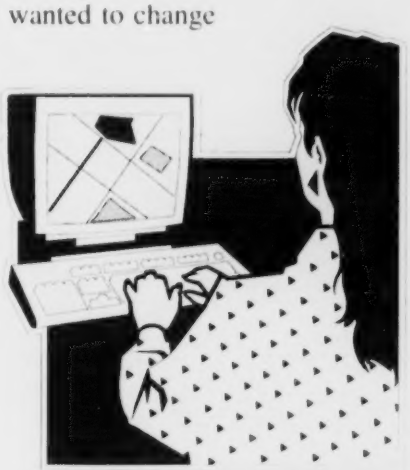
Likewise, have them explore the question from the other direction, that is, states experiencing slow growth or population loss. Also spend time having them hypothesize relationships using some of the other data, such as high levels of international migration and an above-average proportion of non-English speakers. Some of the things that students suggest may not actually be happening but the point is to get them to engage in crafting geographic questions and hypotheses.

Some of the items they suggest may be true only in specific regions or states. For instance, in many midwestern states, slow growth, decline, and/or out-migration are in part a function of the long-term loss of young people moving away from farms and rural communities and leaving behind large proportions of older persons who are beyond child-bearing years. Elsewhere, a large elderly population means growth and expansion, as seen in the sunbelt especially in Arizona and Florida. With such regional mental maps and knowledge, students can further hypothesize relationships. For example

"I believe that with a growing elderly population there is an increase in health-related professions, age-related service jobs, and the sale of health-related products."

9) Once the students have exhausted this brainstorming activity, ask them to consider how they would go about furthering their research. In essence, they need some or all of the geographically related data that their questioning and hypothesis-building efforts have suggested and they will want to be able to map the information to test some of their hypotheses.

Before launching into such a project, have the students spend a few minutes recognizing what they have just accomplished as groups working with a single data item and how long it took them to accomplish it. They have rearranged tabular data, converted them into codes, mapped them, and analyzed them. Have them also recognize what would happen to each of their hand-drawn maps if they wanted to change them. Now, have them consider repeating this process with the list of data items they have just generated.



Ask the students to consider how a GIS would help them in undertaking this possible research project. Consider exploring the three lessons in *Activity set 1* (pages 6–18 of this booklet), if you have not done so. These will give the students a context into which to place GIS and computerized data manipulation, mapping, and analysis.

Additional idea:

1) If you would like your students to go further with this data acquisition, mapping, and analysis activity, consider the following. Initially, have them consider using the mapped data presented on the *Explore Your World with a Geographic Information System* poster. As they study the images, do any of the data layers shown provide them with new geographic questions and answers? For instance, do they find there is a relationship between levels of natural increase and farming activity?

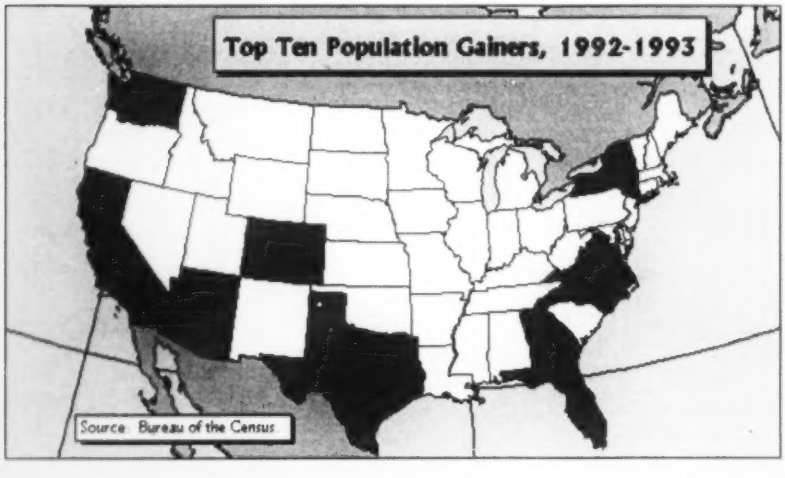
   Since the poster map images are drawn primarily with a different level of geography—counties—consider having the students convert these into state-level depictions. This will mean having the students generate ways of estimating state patterns from finer resolution presentations, such as creating categories of farmland coverage or precipitation using labels like "a little," "some," and "a lot." Once they have exhausted the map images, consider using readily available state-level data sets such as those found in the reference or government documents section of the library or available on-line. Two excellent Census Bureau publications to explore are the *Statistical Abstract of the United States* and the *State and Metropolitan Area Data Book*.

Growth Rate of California's Population Drops Below the National Average

U.S. Census Bureau, Washington, D.C.

For the first time in twenty years, California's population grew at a slower rate than the nation as a whole. Its 1.0 percent rate of growth last year was below the national rate of 1.1 percent, according to new estimates released by the Department of Commerce's Census Bureau.

California's population increased more than twice the national rate in the 1980s. Bureau analyst, Edwin Byerly, says "California, with a 1993 population of 31.2 million, was the slowest growing state in the nation's fastest growing region. The West grew 1.7 percent between July 1, 1992 and July 1, 1993, with California's 1.0 percent rate of growth being the slowest of any Western state."



The estimates show that nine of the nation's ten fastest growing states are in the West. Nevada led all states, with a 3.9 percent growth rate between 1992 and 1993. Idaho was second at 3.1 percent, followed by Colorado at 2.9 percent, Utah and Arizona each at 2.7 percent, New Mexico and Washington each at 2.2 percent, Montana at 2.1 percent, and Oregon at 2.0 percent. Georgia at 2.1 percent was the only non-western state in the list of ten fastest growing states.

Massachusetts and Maine (each 0.3 percent), North Dakota (0.1 percent), Connecticut and Rhode Island (each -0.1 percent), and the District of Columbia (-1.2 percent) were among the slowest growing or declining states last year.

The ten states with the highest numerical population increases between 1992 and 1993 were Texas at 349,000 and California at 315,000, followed by Florida with 196,000, Georgia with 144,000, Washington with 113,000, North Carolina with 109,000, Arizona with 104,000, Colorado with 101,000, Virginia with 96,000, and New York with 88,000.

Two states–Connecticut (-2,000) and Rhode Island (-1,000)–and the District of Columbia (-7,000) experienced population declines between 1992 and 1993. The nation as a whole expanded its population from 255.1 million in 1992 to 257.9 million in 1993, an

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increase of just over 2.8 million persons. Nearly one-third of the growth was attributed to international migration.

Other findings include

- The South maintained position as the second fastest growing region, posting a 1992–1993 increase of 1.4 percent or nearly 1.3 million people. The Midwest followed at 0.7 percent and the Northeast region at 0.5 percent.

- During the 1980s, three sunbelt states—California, Florida, and Texas—grew at a rate more than twice the national average. In the last year (1992–1993), none of these states grew at twice the national average.

- From 1992 to 1993, the two largest states, California (-1.2 percent) and New York (-1.0 percent) had the highest domestic out-migration rates of any state. This domestic out-migration was partially balanced by international migration. In fact, almost half the international migrants to the United States settled in just these two states.

- Additional states with high rates of domestic out-migration (greater than 0.5 percent) last year included the District of Columbia, Connecticut, Rhode Island, Hawaii, Massachusetts, Louisiana, and North Dakota.

- States with high rates of domestic in-migration (greater than 1.0 percent) were Nevada, Idaho, Colorado, Arizona, Montana, Oregon, Washington, and Georgia.

- States with rates of international immigration (greater than 0.5 percent) were California, New York, the District of Columbia, Hawaii, and New Jersey.

- States with high rates of natural increase (births minus deaths greater than 1.0 percent) were Alaska, Utah, California, Hawaii, and Texas.

- States with low rates of natural increase (births minus deaths less than 0.5 percent) were West Virginia, Pennsylvania, Maine, Florida, Iowa, and Arkansas.

(December 29, 1993 [Press Release CB93-219]. For additional detail, see the data table *U.S. Population Estimates 1990–1993* on page 40.)

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U.S. Population Estimates, 1990–1993

(In thousands. Includes Armed Forces residing in each state.)

Region, division, and state	April 1, 1990 (Census)	July 1, 1991	July 1, 1992	July 1, 1993	Change July 1, 1992 to July 1, 1993		Components of change July 1, 1992 to July 1, 1993				
					Population change	Percent change	Births	Deaths	Net movement from abroad: International migration	Net movement from abroad: Federal U.S. citizen	Residual change[1]
United States	248710	252137	255078	257908	2830	1.1	4037	2223	894	122	-
Northeast	50809	50970	51121	51355	234	0.5	754	486	241	7	-283
New England	13207	13201	13196	13230	34	0.3	188	119	35	3	-72
Middle Atlantic	37602	37769	37925	38125	199	0.5	567	367	206	4	-211
Midwest	59669	60180	60639	61070	431	0.7	907	545	98	9	-37
East North Central	42009	42392	42719	43017	298	0.7	649	380	81	4	-56
West North Central	17660	17788	17920	18054	133	0.7	257	165	17	5	19
South	85446	86920	88185	89438	1254	1.4	1386	793	205	65	391
South Atlantic	43567	44436	45092	45738	646	1.4	676	413	112	44	226
East South Central	15176	15350	15532	15717	185	1.2	233	151	7	7	89
West South Central	26703	27134	27561	27983	422	1.5	476	229	85	14	75
West	52786	54066	55133	56044	912	1.7	991	399	350	40	-71
Mountain	13659	14021	14379	14776	396	2.8	243	105	28	8	221
Pacific	39127	40046	40753	41269	515	1.3	748	293	322	32	-292
New England											
Maine	1228	1236	1236	1239	3	0.3	15	11	1	1	-3
New Hampshire	1109	1108	1115	1125	10	0.9	16	9	1	-	2
Vermont	563	568	571	576	4	0.8	8	5	1	-	1
Massachusetts	6016	5995	5993	6012	20	0.3	87	55	21	1	-34
Rhode Island	1003	1004	1001	1000	-1	-0.1	15	10	2	-	-8
Connecticut	3287	3290	3279	3277	-2	-0.1	47	29	10	1	-30
Middle Atlantic											
New York	17990	18047	18109	18197	88	0.5	284	168	144	3	-174
New Jersey	7730	7773	7820	7879	59	0.8	119	73	47	1	-35
Pennsylvania	11882	11949	11995	12048	53	0.4	164	126	16	1	-2
East North Central											
Ohio	10847	10940	11021	11091	70	0.6	168	102	9	1	-6
Indiana	5544	5607	5658	5713	54	1	83	51	3	-	19
Illinois	11431	11525	11613	11697	84	0.7	191	104	50	2	-55
Michigan	9295	9375	9434	9478	44	0.5	138	81	15	1	-28
Wisconsin	4892	4947	4993	5038	45	0.9	69	43	4	-	15
West North Central											
Minnesota	4375	4426	4468	4517	49	1.1	65	36	6	-	14

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Iowa	2777	2790	2803	2814	11	0.4	38	27	2	-	-1
Missouri	5117	5156	5191	5234	43	0.8	75	51	4	1	15
North Dakota	639	633	634	635	1	0.1	9	6	-	1	-3
South Dakota	696	702	708	715	7	1	11	7	-	-	2
Nebraska	1578	1590	1601	1607	7	0.4	23	15	1	1	-3
Kansas	2478	2491	2515	2531	15	0.6	37	23	3	2	-4
South Atlantic											
Delaware	666	681	691	700	9	1.4	11	6	1	-	3
Maryland	4781	4863	4917	4965	48	1	76	39	14	3	-7
Dist. of Columbia	607	594	585	578	-7	-1.2	10	7	4	1	-14
Virginia	6187	6288	6394	6491	96	1.5	97	51	17	15	18
West Virginia	1793	1799	1809	1820	11	0.6	22	20	1	-	9
North Carolina	6629	6749	6836	6945	109	1.6	103	61	5	9	53
South Carolina	3487	3561	3603	3643	40	1.1	56	31	2	4	9
Georgia	6478	6628	6773	6917	144	2.1	111	55	10	6	72
Florida	12938	13273	13483	13679	196	1.5	191	143	58	7	83
East South Central											
Kentucky	3685	3715	3754	3789	35	0.9	53	36	2	2	14
Tennessee	4877	4952	5025	5099	74	1.5	74	48	3	1	44
Alabama	4041	4090	4138	4187	49	1.2	63	41	2	2	24
Mississippi	2573	2592	2615	2643	28	1.1	43	26	1	1	8
West South Central											
Arkansas	2351	2371	2394	2424	30	1.3	35	26	1	-	20
Louisiana	4220	4244	4279	4295	17	0.4	72	38	3	2	-22
Oklahoma	3146	3168	3205	3231	26	0.8	48	31	3	2	5
Texas	16987	17352	17683	18031	349	2	322	134	78	10	72
Mountain											
Montana	799	807	822	839	17	2.1	11	7	-	-	12
Idaho	1007	1038	1066	1099	33	3.1	17	8	1	-	22
Wyoming	454	458	465	470	6	1.2	7	3	-	-	2
Colorado	3294	3370	3465	3566	101	2.9	54	23	6	3	61
New Mexico	1515	1547	1582	1616	35	2.2	28	12	4	1	13
Arizona	3665	3746	3832	3936	104	2.7	66	31	10	2	57
Utah	1723	1767	1811	1860	48	2.7	37	10	2	-	19
Nevada	1202	1288	1336	1389	52	3.9	22	10	4	1	36
Pacific											
Washington	4867	5016	5143	5255	113	2.2	79	38	12	5	55
Oregon	2842	2919	2972	3032	60	2	41	26	6	-	39
California	29760	30407	30895	31211	315	1	596	220	295	21	-377
Alaska	550	569	588	599	11	1.9	12	2	1	2	-1
Hawaii	1108	1135	1156	1172	16	1.4	20	7	7	4	-9

Note: These estimates are consistent with the population as enumerated in the 1990 census, and have not been adjusted for census coverage errors. 1. The bulk of the residual change component is internal (domestic) net migration, although we have no reliable way to quantify it. The residual change figure is also affected by any inaccuracies in input data or variations in implementing the estimating method. - Represents zero or a number which rounds to zero. Source: Bureau of the Census, Washington, D.C.

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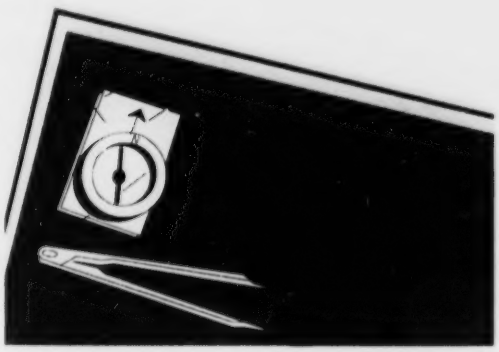
Activity set 2, lesson 3
As you like it:
A geographic guide to where you really want to live



Goals:

The goals of this activity are to help students

1) Engage in personal decision making around possible future states of residence.
2) Analyze the mental geographic databases they used in the process.
3) Explore methods of creating and presenting geographic information.
4) Give evidence of how personal characteristics and preferences may influence people's perceptions of places, regions, and the internal maps they carry.
5) Consider how a GIS would be useful in organizing, displaying, and analyzing the geographic data in this exercise.

Objectives:

As a result of this activity, students will be able to

1) Create geographic data.
2) Quantify, map, and analyze information contained in personal mental maps.
3) Speculate on other data useful in furthering their research.
4) Develop and test geographic generalizations.
5) Interview adults to analyze differences in perceptions about locations in the United States.

Materials:

- Copy of the poster *Explore Your World with a Geographic Information System*
- Wall-sized map of the United States displaying at least state boundaries
- Copies of Residential Preference Survey form (prepared prior to class)
- Copies of handouts and lists from previous activities
- Copy of the Census Bureau's *Statistical Abstract of the United States* or *State and Metropolitan Area Data Book*, an almanac, or places-rating guide with state-level data
- Classroom set of colored pencils/markers
- Copies of blank outline maps of the United States showing state boundaries

Procedure:

1) Many of the preceding activities have challenged the students to examine geographic information about the world around them through the eyes of other people, sometimes from other time periods. This activity, while it will engage the students in conducting

interviews with family members, is aimed at inviting them to explore their personal perceptions, geographic databases, and mental maps of the United States. In the process, they will be experiencing first-hand how geographic data are created.

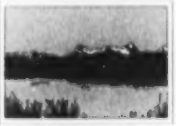
Inform the students that they will be investigating geographic patterns about the United States. However, this time they will be the subjects of their investigations. In essence, they will be answering the question, "Where would they really like to live?" The geographic focus of their explorations will be states in the United States.

In short, the students will answer this residential preference question individually, create a class summary to examine similarities and differences between their individual and collective choices, map the results, and discuss the reasons behind their individual choices. As a part of this discussion, they will summarize the listing of reasons into a class inventory of key factors influencing their choices. (As a way of extending this activity, they will explore, acquire, and map a sample of other state-level data items that their research suggests has a relationship to their preferences.)

Once they have completed the exercise in class, they will continue their investigation by conducting interviews with a family member(s), preferably a parent(s). They will bring these survey forms back to class, summarize, and map the results. This part of the exercise will allow them to study potential variations in choices based on differences in the age of respondents and other characteristics they may include in their questionnaire as well as test geographic hypotheses they will develop.

2) Begin by dividing the class into small groups of 4-5 students. Provide each group with colored markers and a small number of blank page-size U.S. maps showing state boundaries. Also, distribute copies of the *Where in the U.S would you like to live?, A residential preference survey* handout you will be creating prior to class. (See *Example residential preference survey form* on page 44 for a sample with recommended questions.) At the same time, direct the students' attention to a wall-sized map of the United States that shows at least the boundaries of the individual states (and hopefully identifies the locations of key cities and other important geographic features such as mountain ranges).

Ask the students to imagine that they can choose to live anywhere that they want in the nation. They have the support of friends and/or family for such a move and the money necessary to make it happen. The only thing they have to do is to decide where. Since there are plenty of exciting locations across the country, you have created a questionnaire to help.



3) Using the survey form and the wall map as a visual context, ask the students to first, individually, examine the possibility of living in each of the fifty states and report at least one reason why they feel the way they do. On the survey form, have them score each state using a range of 5 to 1–a score of 5 meaning "You bet I would live here!" down to a value of 1 meaning "No way." (See the example survey form for the meaning of all five values.) Also have them respond to a question noting whether they have ever lived in or visited an individual state before.

Example residential preference survey form

This gives you an example of the kinds of questions to include in the questionnaire that you will prepare for your students' use. We suggest using at least those shown. You may wish to gather other pieces of information or ask other questions. If you do, involve the students in this process.

Where in the U.S. would you like to live?
A residential preference poll

Age:			Gender:					
State	Have you ever visited or lived here?		Would you like to live here? (Use these scores: 5=You bet, 4=Yes, 3=Maybe, 2=I doubt it, 1=No way.)					Why do you feel that way? (Provide a written reason or two for your preference.)
Alabama	yes	no	5	4	3	2	1	
Alaska	yes	no	5	4	3	2	1	
Arizona	yes	no	5	4	3	2	1	
⋮	⋮	⋮	⋮					
⋮	⋮	⋮	⋮					
Wisconsin	yes	no	5	4	3	2	1	
Wyoming	yes	no	5	4	3	2	1	

Using a blank copy of the survey form, have each group total their individual scores for each state to create a composite score for the states. Collect the group scores, summarize to obtain a single set of class values for each state, and divide each summarized state value by the number of students in the class to determine a class average.

For instance, let's assume a class has been divided into three working groups. Each student has completed the survey and each group has totaled the responses of its members. The Alabama scores from the groups are 17, 23, and 29. These total 69. There are seventeen students in the class. Therefore, the average class score for Alabama is 4.06 [69/17=4.06]. Using the scale presented in the example survey form, this means the class has said "yes" to Alabama as a state in which to live. Display these fifty values for the class to see using the chalkboard or an overhead transparency.

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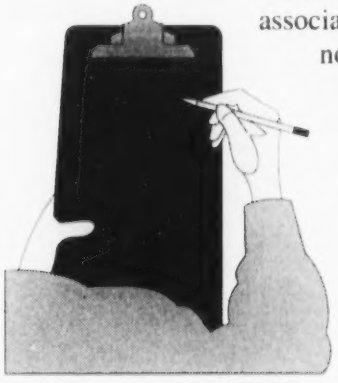
4) Next, have the students map their preference data. As a class, rank the composite state values developed in step 3 from highest to lowest. The state with the highest score will be the class' number one choice for state of residence; the state with the lowest score will be its last choice.

Using this ranked data set, blank page-size U.S. maps, and colored markers/pencils, have each group design a map of the class' residential preferences using the quantile mapping method described in the previous lesson, *Quantile mapping: More than GIS-t the facts*. (**Note:** While the students create group maps, prepare a map transparency displaying the same data for subsequent discussions.)

Once complete, discuss the results of this mapping operation by having the students observe any geographic patterns and by offering examples of differences between the class' choices and their individual selections. Are there any surprising differences between the collective responses and those of individual students? Have them take note of the score/ranking for their current home state and states adjacent to it. What do they notice?

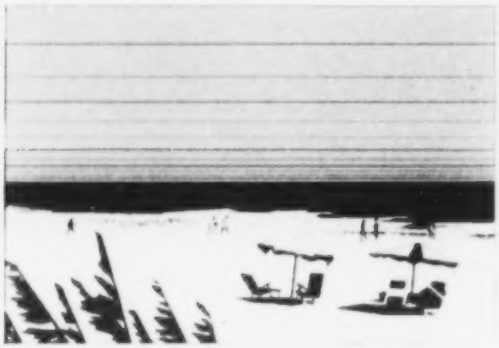
5) Direct the students to begin exploring some of the reasons behind their preferences first by summarizing, mapping, and analyzing the data in the question "Have you ever visited or lived here?" This will allow the students to explore associations between prior personal experience with a state and the notion of relocating there. Consider doing this as a class. Have each group designate a group spokesperson to tally and report the "yes" and "no" responses for each state. Summarize these totals and calculate the percent of students responding "yes" for each state. Using this data set, create a new high-to-low ranking. The state with the highest percentage of "yes" responses will represent the state with which the students have the highest personal experience. The converse will also be true. As was done in step 4, have each group create a quantile map of this data set. In completing this, use the same color scheme as before. This will help the students see similarities and differences between their residential preference and personal experience maps.



6) Discuss the results of this mapping operation. What do the students see? Are there any geographic patterns? Their current home state is probably in the top quantile (and may be the top state). What do they notice about states surrounding it? What are other states with which they have high levels of experience?

Now have the students compare the geographic display on both maps. Where are there similarities, differences? Does prior experience necessarily mean someone is more apt to

choose a state as a possible future home? Ask them to note complete mismatches, for instance, states with which they have no prior experience but to which they may yearn to relocate such as Hawaii. Ask them how they would explain this difference. What information are they using to arrive at their decision? Use these questions as a transition into a discussion of the reasons the students recorded for their individual preferences. (See the *Sample inventory of reasons for residential preferences* on page 47 for ideas and samples of possible responses.)



7) Begin this segment of the exercise by asking the students to consider what makes some states good places to live and others not. Using their residential preference map, tag a few high- and low-ranking states and ask the students to discuss their choices by referencing their reasons for rating a state one way or another. (**Note:** Depending upon their answers, you may wish to separate the positive from the negative responses.)

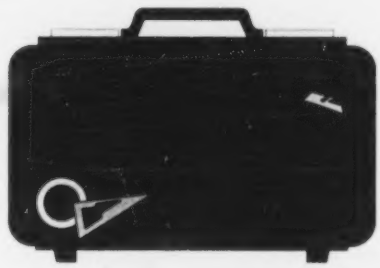
Using the wall-sized U.S. map as a visual context, begin listing some of the key state-by-state reasons on a chalkboard or a transparency.

- Do any geographic patterns begin emerging from this discussion?
- Where is the information that is driving the students' choices coming from (especially information about the economic, social, and physical environments)?
- Is it safe to assume that their mental databases match the real world?

To begin testing this, consider using the map images found on the poster *Explore Your World with a Geographic Information System*. For instance, reasons such as "too many people," "too dry a climate," "desire for rugged terrain," and others can be explored. Ask the students to compare their mapped choices with some of the poster images. Have the students recognize that many of their reasons represent real-world mappable data, such as crime, geo-hazards (tornadoes and earthquakes), and climate. Also, ask them to consider how opinions as well as facts help shape decisions.

Sample inventory of reasons for residential preferences

Here are examples of some of the reasons people give when discussing what would influence their decision to move (or not to move) to a particular location. In essence, what are some of the attributes of a place that might pull someone there or potentially cause them to beat a hasty retreat? Consider using the major categories in this list as a series of umbrellas under which you can place, categorize, and possibly collapse individual responses.



Major categories	**Individual reasons**
Family and friends	"This is where my home is."
	"All my friends are here."
	Proximity to/Distance from relatives
Economic considerations	Lots of jobs/High unemployment
	Great colleges/universities
	"The place to pursue my career."
Social considerations	Quality of life
	Too many people/Too few people
	Clean air/Smog
	Very safe/Crime and gangs
Climate and physical environment	No snow/Lots of snow
	Too humid/Too dry
	Continuous summer/Four seasons
	Mountains/Forests
	Deserts/Beaches
	Water (ocean, lakes, rivers)
	Tornadoes/Hurricanes/Earthquakes
Cool places and activities	Cultural attractions/Parks
	Theme parks/Shopping malls
	Rock climbing/Hockey/Wind surfing/Rodeo
	Dance/Theater/Movie studios

(**Note:** If you wish to further extend this activity, consider having students explore acquiring, mapping, and analyzing some of their reasons as state-level data sets such as those found in the Census Bureau's annual *Statistical Abstract of the United States* or an almanac or places-rating guide. These and other print and electronic data sets are available in many public and university libraries in the government documents or reference sections. If you decide to engage the students in this exploration, use the quantile mapping method used earlier as a way of standardizing your geographic displays and analyses.)

Direct the students' attention back to the chalkboard/transparency listing of reasons for and against relocating to various states. Expand the content of this inventory by asking the students to offer other reasons why they would or would not move to a particular state. As this listing grows, have them note that some of their responses overlap and can be combined with others into broader categories. Ask the students to begin collapsing their many answers into a few key categories. Consider doing this by asking them to address what they feel are going to be the most important motivations for them in choosing a place to live. (See the *Sample inventory of reasons for residential preferences* for five suggested categories: family and friends, economic considerations, social considerations, climate and physical environment, and cool places and activities.)

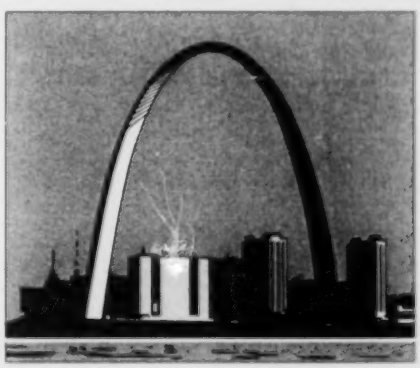
Once complete, have someone make a record of the class' major categories and a selection of the individual reasons that fall under each major category. (See *Sample inventory of reasons for residential preferences* for a suggested format of this record.) The students will use copies of this record in their interview with a family member.

Using a show of hands and their list of major categories, ask the students to pick the single-most important motivation for them in choosing their next place to live (e.g., family and friends, economic considerations). Based on the totals, create a percentage distribution of the results. Have someone make a record of these results. The students will compare their results to this question with those from their parents.

8) Once they have completed the exercise in class, direct the students to continue their investigations by conducting interviews with family member(s), preferably a parent, using their residential preference questionnaire. Prior to the actual interviews, spend time having the students offer their collective scenario of what they think the data coming from their families will look like. What do

they hypothesize as the top states of choice? What do they believe will be the key reasons for preferring a particular state? Record these hunches and observations for later testing.

For consistency in comparing results, have the students ask the family member(s) the same questions they answered. One exception to this might be the reasons behind their choices (why do you feel that way?). Here, it may be easier to use the class' list of major categories of reasons (as described in step 7) as an interview flash card, that is, allowing the respondent to select one or more of the categories in responding about an individual state. Another recommended interview prop is a U.S. atlas or a copy of the page-size U.S. map. Also, have the students ask the family member(s) to pick the single-most important motivation in choosing the next place to live. (**Note:** One answer students may receive is that the parent or family member does not want to move. If this is the case, instruct them to ask and record why the family member does not wish to move. The list of major categories of reasons will probably work here.)



Have the students bring all of the family responses back to class. Once retrieved, have them repeat steps 3–7. Throughout these steps, direct the students back to their data sets and maps. What differences and similarities do they see between their choices and those of their families? In noting the differences, what reasons might they suggest to explain the variations: age, gender, prior experience with a location? What other information do they think would be required to delve further into these differences? How would they go about obtaining it?

9) Throughout this exercise, help the students recognize that they have been actively engaged in creating a series of geographic data sets and the methods they have used are similar to those used in the everyday world. Also, help them appreciate that the range of data preparation, mapping, and research activities they have undertaken are the same kinds of activities performed using a GIS. (**Note:** Direct the students' attention to quartet of images on the left side of the *Explore Your World with a Geographic Information System* poster as a brief reminder of what a GIS is.)

As a final discussion, have the students discuss the advantages and disadvantages of undertaking this exercise or similar research using a GIS. As one advantage, help them recognize the ease and speed of mapping their survey data as well as other data sets using a GIS.

Additional ideas:

1) Ask the students to consider the effect of redoing their examination of residential preference by focusing on cities or regions within individual states, most especially, in

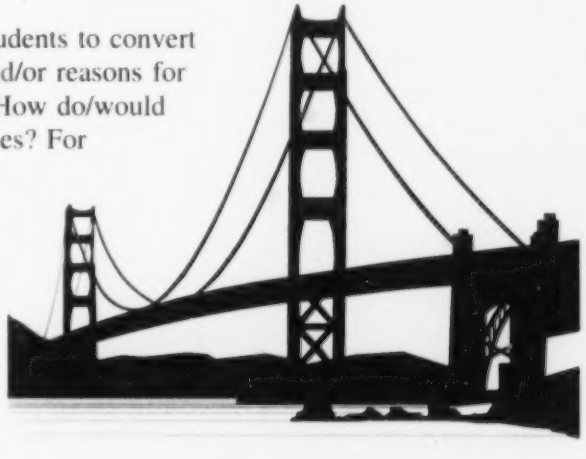
those states that were in the middle to the bottom of their ranking. A state may not be high on their list simply because of a specific place or region. For example, instead of considering Texas as a possible relocation site, the students might divide the state into regions made up of single metropolitan areas and outlying rural or more remote territories.

One possible Texas regional configuration might include the following areas: the Dallas-Ft. Worth area, Houston, San Antonio, Austin, El Paso, the Panhandle, the Gulf Coast, the Rio Grande River Valley, other locations in East Texas, and other locations in West Texas. How does this regional orientation affect their decisions? Are these, in fact, some of the kinds of geographic filters that came into play in their earlier explorations?

2) On a state-by-state basis, ask the students to, as best as possible, summarize their reasons for and against choosing a particular state as a potential new home. To make this as easy as possible, consider summarizing these motives into the major categories of reasons shown in the *Sample inventory of reasons for residential preferences*. What do the students find as the top motives for and against a specific state? Do they notice any geographic patterns? Is there any association between these state-by-state reasons and their ranking, and the map of their most- and least-preferred states? Where it is meaningful, have them create additional quantile maps of some of these factors.

3) Have the students explore another way to create geographic data about their residential preferences and compare the results to their main data set. Once the students have answered all of the other questions on the questionnaire, ask them to circle the name of the state that represents their number one choice. Using a roll call, record and tally the students' choices on a chalkboard or transparency. Have the students map these results. Discuss these findings in reference to the students' main residential preference database. How are these results different from/similar to their first set of information? Do these top states match the upper quantile(s) in their initial map? Do the maps show the same thing or something different? Have them notice that the new map probably does not display data for every state in the entire country. Do they feel that one set of findings provides a more useful picture of residential preference than the other?

4) Consider an art project. Challenge the students to convert aspects of their individual preferences and/or reasons for their choices into sketches or drawings. How do/would they picture elements of their ideal choices? For instance, their reasons may suggest a desire for a rural pace or life in New York City, the desert, or the mountains. Their images might be a collage of their favorite things or singular items that say it all for them, like the Golden Gate Bridge.



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E-mail
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